HORTICULTURE
Instructional-cum-Practical Manual

Volume IV

FUNDAMENTALS OF FRUIT PRODUCTION

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Project Coordinator

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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Foreword

The programme of vocationalization of higher secondary education has been accepted by the country as it holds great promise for linking education with the productivity and economic development of the country by providing education for better employability of the youth

In view of the importance of the programme the NCERT is making an all out effort to provide academic support to the implementing agencies in the States One of the major contributions of NCERT is in the field of curriculum development and in the developement of model instructional materials. The materials are developed through workshops in which experts, subject specialists, employers' representatives, curriculum framers and teachers of the vocational courses are involved. These materials are then sent for try out in schools and feedback is collected through questionnnaires and through direct contact The materials are also sent to experts for comment before they are published.

The present manual on Horticulture has been developed in the manner described above and is meant for the students studying Horticulture and allied courses. It is being published for wider dissemination amongst students and teachers throughout the country I hope they will find the manual useful.

I am grateful to all these who have contributed to the development of this manual. I must acknowledge also the immense interest taken by Prof. A K Mishra, Head, Department of Vocationalization of Education in inspiring his colleages in their endeavours to develop instructional materials. Dr. A.K Dhote, Lecturer, functioned as the Project coordinator for the development of this title in association with Dr A.K. Sacheti, Reader They have my appreciation and thanks for planning, designing

and conducting the workshops, for technical editing and for seeing manual through the Press

Suggestions for improvement of this manual will be welcome.

P.L. MALHOTRA
Director
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Preface

Ever since the introduction of vocationalization in our school system by several States in our country the pauicity of appropriate instructional materials has been felt as one of the major constraints in implementation of the programme and a source of great hardship to pupils offering vocational studies at the higher secondary stage.

The Department of Vocationalization of Education of the National Council of Educational Research and Training, New Delhi has started a modest programme of developing instructional manuals of diverse types to fill up this void in all major area of vocational education The task is too gigantic to be completed by any single agency but the model material being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area These are based on the national guide lines developed by a working group of experts constituted by NCERT

The present manual is on "Fundamentals of Fruit Production" and is common portion of the Horticulture or related courses in a number of States. It contains activities (Practical exercises) to be performed by pupils with simple steps to follow, precautions to be taken and data to be obtained and processed. Each activity is complete with brief theoretical information, objectives, behavioural outcome, evaluation etc It is hoped that the pupils will find them immensely useful.

The Manual has been developed by a group of experts as authors in a workshop held at the University of Agricultural Sciences, Bangalore The names are mentioned elsewhere and their contributions are admirably acknowledged. Our thanks are also due to Dr. K.L. Chadha, Director, Indian Institute of Horticultural Research, Banglore for the pains he took in varifying the authenticity of contents of the manual. Dr. A.K. Sachetic, Reader and Dr. A.K Dhote, of the Department of Vocationalization Education deserve special thanks for editing and bringing the materials in the

present form. The assistance of all in the University of Agricultural Sciences, Bangalore and Department of Vocationalization of Education, N.C.E R.T., is also thankfully acknowledged.

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About the Manual

Under the programme of vocationalization of Education about 20 different groups of vocational courses in the area of agriculture have been introduced by nine States and three Union Territories so far. These courses have been running for the last six or seven years From the very beginning the Department of Vocationalization of the Education in the NCERT has been working hand in hand with the State organisations concerned through various programmes organised for State officials, vocational teachers, and others. In fact, by now the Department has conducted on-the-spot studies of vocational programme in large number of States, to find out merits and demerits of the programme and to suggest appropriate measure to resolve the problems in 'vocational agriculture education' These programmes have revealed that there was a great dearth of suitable textual/instructional materials, the need for practical manuals, especially, was urgently felt. The development of instructional materials and the imparting of practical training become even more important when one considers the purpose for which the vocationalization of education programme has been launched The main aim of the programme is to prepare the pupil for purposeful and gainful employment (wage-earning or self-employment)

The Department constituted a Working Group during the year 1982 to formulate guidelines for developing models for a variety of instructional materials.

Based on the guidelines formulated by the Working Group, Horticulture, which is an important and popular vocational course in agriculture, was selected by the Department for the purpose of development of instructional materials in a phased manner. To begin with, the development of instructional-cum-practical manuals has been taken up

The content of Horticulture and similar courses offered by the States and Union Territories under different titles was thoroughly analysed and it was felt that six manuals would be necessaty to cater to the needs of the course The present manual on *Fundamentals of*

Fruit Production is one of them This manual is intended to help both teachers and pupils in the study of fundamental inputs of fruit production as preparation for this vocation While developing the manual, care was taken that it should include the maximum number of Activity Units (practical exercise) so that it can fulfil the requirements of the course prescribed by the States and Union Territories in the Horticulture as well as in other vocational courses

These Activity Units are essential to develop the required vocational skills in the pupils The manual explains in detail the 'What', 'Why', and 'How' of these Units

In the manual each Activity Unit has been dealt with under several sub-heads, viz , instructional objectives, relevant information, precautions, materials required, procedure, observations, expected behavioural outcomes and questions

Before commencing the actual work under any Activity Unit, the teacher should know what exactly the pupils have to learn and do, and should also assess whether they will be able to do that Therefore, in the beginning, instructional objectives for the pupil should be framed in behavioural terms by the teachers

In order to acquaint the pupils with the Activity Unit the teacher should provide them with the required theoretical knowledge or information relevant to the activity. This will help the pupils to properly understand the Activity unit.In other words, the 'what' and 'why' parts of the Activity Unit should be explained in advance by the teacher

Once the pupils have understood the relevant theoretical instructions, the teacher should tell them about the precautions which are to be taken before and during the actual execution of the Activity Unit. This will facilitate smooth working The 'how' part of the Activity should be explained by the teacher in the 'procedure' which pupil should follow while performing the Activity Unit

Under the sub-head 'observations', the teacher should tell what to observe and in view of that the pupil should observe the situation, take readings, note down the temperature and similar other points, under each Unit, these may vary from Unit to Unit. Wherever calculations are required to be done to obtain the reaults, this should also be indicated under this head or under separate head.

At the end of the Activity the pupil will have acquired certain

abilities which should be closely related with the instructional objectives formulated for each Activity Unit These abilities should be listed under the sub-head 'expected behavioural outcomes' Evaluation should be based on the abilities acquired and it should be done by the teacher concerned.

For evaluating each aspect, the teacher will use a four-point scale, i e., A, B, C & D, and for each Activity Unit the Grade Point Average can be calculated as indicated below.

Suppose there are four aspects, each carrying equal weightage, and a pupil obtains 2A's, IC and ID and if A =4 point, B =3, C= 2 and D =1 point; then, based on the grades, the pupil will get 11 points When the number of points obtained is divided by the total number of aspects examined, it will give the Grade Point Average, which, in this case, is 2.75 The tabular presentation is as under

Aspect	*Weightage*	*Grade Obtained*	*Total Points (Weightagexpoint-equivalent to grade obtained)*	*Grade Point Average*
1	1	A	1×4 =4	
2	1	C	1×2 =2	=11/4 =2 75
3	1	D	1×1 = 1	
4	1	A	1×4 =4 11	

At the end of the Activity Unit, some questions relevant to it are also given The pupils should write the appropriate answers after the completion of the Activity Unit and teacher should examine them. If required, he should make suitable corrections and give suggestions. However, answers to these questions will not be considered for the purpose of grading.

Acknowledgement

The following experts participated in the workshop conducted by the NCERT. Their participation as contributors or reviewer is gratefully acknowledged.

Contributors

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Reviewer

Dr. K L. Chadha

Contents

Introduction

Fruits are rightly considered as men's oldest food The techniques of fruit culture and its utilization also received the attetion of man at a very early stage. In India too, cultivation of fruits dates back to ancient times

Fruits are natural sources of Vitamins and minerals. While most fruits are used as protective food, some of them supplement as well as substitute the cereal and other foods in the daily diet

The area under fruits in India is 2 9 million hectares with an estimated annual production of 10.2 million tonnes. The requirements of the present population, on the basis of minimum daily delivery requirement of 30 g fruit for an adult works out to 14.5 million tonnes. To meet the requirement of growing population, the production of fruits has to be stepped up to 21 million tonnes by the turn of the century India with its varied soil and climatic conditions provides almost unlimited potential for increasing fruit production.

Fruit growing is both a science and an art Till recently, it has been a pass-time and a hobby for many people. It is only since the last three decades that fruit growing has been taken up as an avocation and remunerative enterprise. Fruit plants are perenial, and widely varied in their soil and climatic requirements They differ in their mehtods of propagation. Based on their growth, flowering and fruiting habits, they differ in their training and pruning requirements. Their nutritional requirements vary according to their growth and bearing. The kind of manures and fertilizers and mehtods of application and their water requirement have to be varied according to the kind of fruit plant, growth, phases and yield potential

Fruit growing on scientific lines, thus requires a thorough insight into the principles involved in different growth processes of the plant It is, therefore, necessary to acquire mastery over skilled operations to be carried out from time to time in manipulating these processes for full exploitation of the potential of fruit plants.

In this manual, the skills and practices of modern fruit growing and their principles are covered in an easy-to-understand and follow activities. The activities are in a logical sequence. Each activity spells out its objectives, relevant information, detailed step-wise procedure, precautions, observations and calculations to be completed. It is hoped that this Instructional-cum-Practical Manual will be useful to students preparing themselves to take up-fruit growing as a gainful employment, to the commercial fruit growers, or the home gardeners, or the hobbyists.

1. Activity Unit

Selection of Site for Fruit Growing

1.1 Instructional objectives

The pupil should be able to.

— select a site suitable for growing fruits of commerical importance in the region based on climate and soil;
— acquire knowledge about soil and its suitability for fruit growing;
— know about the availability and suitability of irrigation water.

1.2 Relevant information

What is a site?

Climate and soil are the chief natural components of site on which the success or failure of the fruit growing depends. Climate includes several factors like altitude, temperature, rainfall, atmospheric humidity, wind and its direction and hail in hilly areas. The soil includes such factors as soil moisture, texture, chemical composition and temperatures The location of the site determines its distance from the market.

Why site selection is necessary?

Knowledge of the effect of various soil and climatic conditions on fruit growing is very essential for every successful fruit grower, as different fruits differ widely in their soil and climatic requirements. Distance from the market will determine whether perishable fruits with poor keeping quality can be grown and whether marketing facilities are available closeby Soil for fruit growing should be deep (2 metres) as plants are deep rooted. It should be well drained and water table should not be high as it is harmful to

the root system. Soil pH range should be between 6 0 to 8.0. The availability of certain nutrients is strongly influenced by pH. For example micronutrients like iron, manganese, copper and zinc become much less available in highly alkaline soils In such soils, concentration of sodium salts is above 0.1%. Land with gentle slopes are suitable for fruit growing

Most of the sub-tropical fruits cannot be grown beyond an altitude of 1000 metres Similarly, most stone fruits cannot be successfully grown beyond an altitude of 1500 metres

Temperature plays an important role in determining the success or failure of a fruit crop in a given region Higher and lower temperatures than the optimum are injurious to plants and fruits For example trees of mango, banana, papaya, litchi are highly susceptible to frost injury

Wind at the time of flowering and fruiting causes dropping of flowers and fruits. The yield is thus reduced

Facility of cheap labour and transportation for economic production of a crop is essential.

1.3 Precautions

— Select suitable place closer to the city or consumer centre
— Analyse soil and water samples for their suitability.
— Avoid water logged areas.
— Ensure availability of electricity near the site.
— Ensure the availability of labour at cheap rates
— See there is no brick within 1 km of the site

1.4 Material required

(i) Field diary
(ii) Pencil.
(iii) Polythene or cloth bags (25 cm × 15 cm)— 10 Nos.
(iv) Plastic bottles of 250 ml— 5 Nos.
(v) Pick axe.
(vi) Spade.
(vii) Crow bar—1
(viii) Measuring tape
(ix) Luggage labels 20— Nos
(x) Thread ball— One bundle

1.5 Procedure

— Select site nearer to city consumer centre.
Survery the topography of land—undulating, sloping (direction), or plain.
— Select suitable spots for digging pits at 2-3 places in one hectare area. Number of pits may increase according to area and topography.
— Collect the soil samples layerwise from 0 to 60 cm, 60 to 120 cm and 120 cm to 2 metres.
— Put the samples in bags, label individual bags, indicate location of pit and depth.
— Locate source of water nearby (such as old wells or irrigation canals).
— Take the water sample in plastic bottles from 4 to 5 places for testing its suitability for irrigation purposes.
— Get the soil and water samples analysed in a soil testing laboratory.
— Collect the meteorological data from the nearest meteorological observatory for the last 5 years

1.6 Observation

Record or collect the following observation in the tables

Distance from	*Labour Rates*	*Depth of Underground water*	*Distance from power line*	*Transport facility*	*Remark*
City Main Road	Rs. to Rs			e g Bus Train etc	

Mateorological Data for one year (Monthwise)

Month	*Temperature* (°C) Maximum Minimum	Rainfall (cm)	Humidity %	Remarks
1.	2	3	4	5

January
February
March
April
May
June
July
August

September
October
November
December

Mateorological data for 5 years

Year	*Temperature (°C)*	*Rainfal (cm)*	*Humidity (%)*	*Remarks*
1	2	3.	4	5
1984				
1985				
1986				
1987				
1988				

Data of soil analysis

Death of soil profile	*Nitrogen %*	*Phosphorous %*	*Potash %*	*Conductivity mmhos/cm pH at 26°C*
1.	2.	3.	4	5.
0 to 60 cm				
60 to 120 cm				
120 cm to 2 metres				

The pupil will decide the suitability or otherwise of the soil at the site on the basis of the standard soil test values given in the following table

Rating of soil test values

pH	6 0 and below acidic	6 0–8 3 normal	8.3 and above alkaline	
Conductivity	1–2	2–3	3–0	

mmhos/cm at 25°C	critical for germination	critical for growth of salt sensitive crops	injurious to most crops
	Low	Medium	High
Organic carbon %	0 5	0.5–0 75	0 75
Available nitrogen (kg/ha)	280	280–560	560
Available P (kg P/ha)	10	10–25	25
Available K (kg K/ha)	110	110–280	280

Data of water analysis of collected sample

Salinity hazard	Low	Med	High	Very high
Electrical conductivity (mmhos/cm at 25°C)				
Salt concentration				

Sodium hazard Samples	Low	Med	High	Very high

Residual Sodium carbonate (RSC) me/litre

Unsuitable	Marginal	Safe
2.5 and above	1 5–2 5	2.5

The pupil will decide the suitability or otherwise of the water at the site on the basis of the Standard soil water test values given in the following tables:

Water quality

Salinityl hazard (USDA)	Low	Medium	High	Very high
Electrical Conductivity (mmhos/cm at 25°C)	100–250	250–750	750–2250	2250 and above
Salt concentration (per cent)	0.2	0 2–0 5	0 5–1.5	1 5–3 0

Sodium hazard (SAR)

Low	Medium	High	Very high
0–10	10–18	18–26	26

List of fruit crops already growing in the area

(1) Mango

(2) . .. .

(3) . ..

(4) . .

1.7 Expected behavioural outcome

The pupil acquires the following abilities to:

— select spot for test pits and taking of soil samples,

— decide the suitability or otherwise of soil and water for fruit growing on the basis of soil/water analysis;

— decide fruits suitable for growing on the basis of climatic factors.

The teacher should evaluate the pupil on the basis of above abilities

1.8 Questions

(i) Name various climatic factors governing fruit production.

(ii) What are the desirable characteristics of soil for fruit growing?

(iii) Name four plant nutrients whose availability is affected in highly alkaline soils

(iv) Name factors other than climate and soil, for selection of site for fruit growing.

(v) How do you decide whether water available is fit for irrigation of fruit crops at a particular place?

2. Activity Unit

Fencing—Live and Non—Living

2.1 Instructional objectives

The pupil should be able to:

— acquire sufficient knowledge about living and non-living fencing;
— identify plants used in the live hedges and their mehtod of planting,
— know the types of materials to be used in making non-living fence and their cost involved,
— erect and maintain living and non-living fences.

2.a Live Fence

2.a.2 Relevant information

What is a fence?

Any protection used all around the orchard to protect it against wild animals, monkeys and tresspassers is called fence. Following are the some of common plants used for making live fences.

(i) *Inga dulsis* (Manila tamarind, Madras thorn, or *Vilayti imli*)

It is grown as a hedge/fence/plant throughout the tropics provided the climate is not too dry. It is widely grown throughout India and forms an attractive and strong thorny hedge/fence.

(ii) *Parkinsonia aculeata L.* (Vilayti kikar, Jerusalem Thorn)

It forms an excellent hedge/fence and bears yellow fragrant flowers It grows in West Bangal, Maharashtra, Andhra Pradesh, Tamil Nadu and the Punjab in areas with rainfall around 75 cm. If trimmed properly, it forms a good protctive hedge It is not eaten

by cattle. It is fast growing and forms an effective hedge in about a year. It needs special care in pruning and training otherwise the lower branches will develop and small animals like rabbits may pass through the gaps. It may be used as a temporary hedge/fence while the permanent one is growing.

(iii) *Proposis juliflora* (Honey locus, Mesquite, or Vilayti Kikar)

It is thorny and drought resistant shrub. Hence it is suitable for dry areas. It aslo serves as a low wind bread if left unpruned The buds are sometimes used as a feed for livestock. If not kept under proper control, it may spread in the neighbourhood It is also of value as firewood.

(iv) *Carissa carandas L* (Karonda)

It is a spiny shrub which makes an effective dense hedge in some parts of India. It can be trained to any height and is often cultivated for its acidic fruit which is usually preserved.

(v) *Casuarina equistifolia*

Popularly known as casuarina in parts of South India, it can be grown as an impenetrable hedge and can be trimmed into shape in a very satisfactory manner. It also stands severe drought.

The other plants which can also be used as live hedges/fence are *Zizyphus* sp., *Duranta plumeri, Cactus* (Nagphani), *Thor (Euphorbia reyleans)* and *Commiphora berryi* Engl (spiny plant)

2.a 3 **Precautions**

— Use fresh seeds.
— Handle the cuttings of cacti and other thorny plants with care.

2.a.4 **Materials required**

(i) Fresh seeds of *Inga dulsis*, *Parkinsonia aculata* Karonda etc. (or seeds of any other fence plant described above).
(ii) Cuttings of cacti or duranta.
(iii) Measuring tape.
(iv) Rope.
(v) Spade
(vi) Pick-axe
(vii) Secateur.
(viii) Weeding hook.

2 a 5 **Procedure**

— Mark the boundary of the orchard
— Prepare beds, 50 cm wide and 15 cm deep along the boundary of the orchard at the onset of the rains.
— Sow the seeds in two rows 30 cm apart, and 2 cm deep.
— Plant cuttings (hard wood) 30 cm long with a minimum of 3 nodes, in two rows The cuttings the two rows should be planted alternately.
— Plant to a depth of 10 cm with at least one node buried in soil.
— Press firmly around cuttings

After care

— Fill up gaps with seeds and cuttings.
— Water the bed as and when required
— Train/prune the plants to gradually increase the width and height of live fence.

2 a 6 **Observations**

(a) The pupil should note the dates of germinations of seeds or establishment of cuttings as below.

Name of Plant .. .. Seed/cutting

Sl No	*Date of sowing/ planting of cutting*	*Date of germination of seed/ sprouting of cutting*

(b) The pupil should also record the following observations

Date of sowing seeds	*Date of germination of seeds*	*Date of planting cuttings*	*Date of sprouting of cuttings*

2 a 7 **Calculation**

The pupil should calculate the cost of raising the live fence

(a) Cost of seed/cutting		Rs ...
(b) Cost of planting		Rs. . .
(c) Cost of pruning		Rs ..
(d) Cost of labour for maintenance		Rs .
	Total	Rs. ....

2.b. Non-living fence

2.b.2 Relevant Information

Barbed Wire This fencing is very good but its initial cost is very high.

Dead thorny branches—May be used in making fences These are not satisfactory and require frequent repairs and replacement.

2.b.3. **Precautions**

Handle barbed wire with care

2 b 4. **Materials required**

(i) Wooden poles	– 2.5 m long
(ii) Angle iron poles	– 2.5 m long
(iii) Stone poles/pillers.	– 2.5 m long
(iv) Dead branches of thorny plants	
(v) Barbed wire.	
(vi) Measuring tape	
(vii) Rope.	
(viii) Spade.	
(ix) Pick-axe.	

2.b.5 **Procedure**

— Mark the boundary to be fenced
— Mark the pits at a distance of 2 m
— Dig pits of 25 × 25 cm size and 50 cm depth
— Put the poles in the pits perpendicular to the ground.
— Fill the pits by cement concrete mixture.
— Fix four barbed wire at a distance of about 30 cm apart on the pole securing them with firm hooks.
— Stretch the wire tightly.

After care

— Stretch the barbed wire whenever found loose
— Make the poles straight and tight whenever found loose.

2.b.6 **Calculation**

The pupil should calculate the cost of raising the fence for one hectare.

a) Cost of poles	. . .	Rs
b) Cost of wire		Rs
c) Cost of cement concrete mixture	.	Rs
d) Cost of labour		Rs
e) Other charges	. . .	Rs
Total		Rs

2.7 Expected behavioural outcome

The pupil acquires the following abilities to:
— known about live and non-living fencing;
— identify plants used in the live hedges and their mehtod of planting;
— know about the types of materials to be used in making non-living fences and their cost involved,
— erect and maintain living and non-living fences
The teacher should evaluate the pupil for the above abilities.

2.8 Questions

(i) Name plants with thorns suitable for live fences.
(ii) Name the plants which are used as live fence and also produce edible fruits.
(iii) Why seeds are sown in two rows for establishing a live hedge.
(iv) Give characteristics of a good live fence
(v) Compare the merit and dements of live and non-living fences.
(vi) Why live fences are preferred to non-live fences?
(vii) Describe how you will develop a non-penetrable live fence.
(viii) Compare the cost involved in establishing living and non-living fences.

3. Activity Unit

Raising the Wind-Breaks

3.1 Instructional objectives

The pupil should be able to:

— know plants suited as wind-breaks and their methods of planting;
— know the advantages of wind-breaks in an orchard;
— raise the wind-breaks.

3.2 Relevant information

What is a wind-break?

A wind break is a row of tall trees planted close together around the orchard, towards the direction of the wind or at suitable intervals in the orchard, in order to give effective protection to the fruit trees and the crop they bear against strong winds For better effectiveness wind-breaks are planted in 2-3 rows. The wind break has maximum effectiveness for a distance of about four time the height of the plant.

Why wind-breaks?

— They reduce the wind velocity and minimize the damage to fruit trees and the crop.
— They minimize the adverse effects of high and low temperatures on plants.
— Activity of pollinating insect is not adversely affected.

Common trees to be used as wind-breaks

i. Shisham— *(Dalbergia sissoo)*
ii. Mulberry— *(Morus sp.)*
iii. Mango— *(Mangiera indica)*

iv Jaman—(*Syzyqium cumuni Skeels*)
v. Jammun—(*Syzyqium fruticosum Roxb*)
vi Jujube (Chinese)—(*Sizyphus jujuba Mill*)
vii Jujube (Indian)—(*Zizphus mauritiana lam*
viii Eucalyptus (Bluegum)—(*Eucalyptus globulus*)
ix Carambola—*(Averrhca caranbola L.)*

3.3 Precautions

— Plant wind-breaks at least 5 m away from the first row of the fruit plants
— Check the growth of feeding roots of wind breaks by timely pruning in the prepared trench.
— Control the insect pests and disease of the wind-breaks in time.

3.4 Materials required

(i) Saplings of plant to be used as windbreaks
(ii) Spade
(iii) Pick-axe
(iv) Measuring tape
(v) Rope
(vi) Crow bar
(vii) Farm yard manure
(viii) 5 % B.H.C or aldrex

3.5. Procedure

Mark the boundry of the orchard.
— Dig pits of 30 cm × 30 cm in row, 1 m away from the fence, at a distance of 1 5 m between pits and 5 metres away from the first row of fruit plants.
— Mark another row 1.5 to 2 m away from the first row and dig pits in the row as before, keeping in view that the pits of the second row alternate with the pits in the first row.
— Fill the pits with the soil mixed with 50 % farm yard manure or compost
— Add about 50 g of 5 % B.H.C. in each pit and mix it thoroughly in the soil.
— Plant the samplings of any one kind of plant in the centre of the pit.
— Press the soil firmly all around the plants

— Water the plants as and when necessary
— Dig a trench of about 50 cm deep and 50 cm wide, 3 m away from the second row of wind-break towards the orchard So that the roots of wind break do not feed the nutrients of the fruit plants

3.6 **Observations**

The pupil should be able to record the following observations

Table 1

Date of Planting	*Saplings* *Number Planted*	*Number Established*	*% of Establishment*
1.	2		3

Table 2

Hight of the Plants in Metres

No of plants	*Jan.*	*Feb*	*March*	*Apr*	*May*	*June*	*Jully*	*Aug.*	*Sep.*	*Oct*	*Nov*	*December*
1												
2.												
3.												
4												
5.												
Total												
Average												

3.7. Expected behavioural outcome

The pupil acquires the following abilities to.

— know about wind breaks,
— identify plants suited as wind-breaks and their method of planting;
— raise effective wind-breaks in the orchard

3.8 Questions

(i) Name various types of plants used as wind-breaks.
(ii) Why wind breaks are used?
(iii) Why close planting is done in plants used as wind-breaks?
(iv) What type of care the wind breaks need?
(v) How do you prevent competition between wind break plants and fruit plants?
(vi) What is the relationship between the height of wind break plants and their efficiency as wind breaks?

4. **Activity Unit**

Preparation of Land for Orchard Development

4.1 Instructional objectives

The pupil should be able to:

- acquire sufficient knowledge about preparation of land for planting fruit trees;
- acquire sufficient knowledge about field levelling;
- cultivate the land by deep ploughing,
- uproot the previously growing shrubs and trees,
- prepare land for orchard development

4.2 Relevant informations

Land preparation and its importance

It is carried out by repeated ploughing, harrowing and levelling the land till it becomes loose and friable. It is required for good plant setting and development During this process stones, weeds, robbing roots of wild trees and shrubs etc are removed. It provides aeration to soil

4.3 Precautions

Check the suitability of land in terms of drainage, fertility, salinity and alkalinity. Check the suitability of water table.

4.4 Materials required

(i) Axe
(ii) Pick-axe
(iii) Spade
(iv) Crowbar
(v) Spirit level
(vi) Mould board plough (bullock drawn)
(vii) Disk plough (bullock drawn)

(viii) Leveller (bullock drawn)
(ix) Seeds of green manuring crop like sannhamp.

4.5 Procedure

— Mark the boundary of the orchard.
— Remove all unwanted trees, shrubs, and other plants present in the orchard.
— Dig the thick stumps of the trees or shrubs up to about 2 m depth and remove them
— Plough and cross plough the land
— Remove stones and stubbles etc
— Level the field for proper drainage
— Sow green manuring crop
— Plough down the green manure crop when it attains pre-flowering stage.

4.6 Expected behavioural outcome

The pupil acquires the following abilities to.
— understand the importance of land preapration;
— prepare the land for orchards,
The teacher should evaluate the pupil for above abilities

4.7 Questions

(i) Why deep ploughing is required?
(ii) Why the previously growing trees and shrubs are removed?
(iii) Why stubbles and root portion of the cut trees are removed?
(iv) Why levelling is done?
(v) Why green manuring is undertaken before actual plantation?

5. Activity Unit

Orchard Layout and Planting

5.1 Instructional objectives

The pupil should be able to.

— acquire sufficient knowledge about orchard layout and planting systems;
— know the advantages of planting with a particular system,
— plant the fruit trees in a particular system,
—calculate the nunmber of plants required per hectare in a particular system.

5.2 Relevant information

What is a layout?

Layout means locating the position of trees, roads and buildings in the orchard being established, and systems of layout refers to the orderly ways of planting the trees

Why layout is necessary

It is necessary due to the following reasons.

1. It enables equal dustribution of areas under each tree
2 It results in least wastage of land.
3. Orchard operation like interculture and irrigation are carried out easily.
4 It makes supervision more easy and effective.
5. There is room for systematic extension of the orchard

Points to be considered while preparing plan of the orchard

(1) Shorter fruit trees may be assigned in the foreground and taller trees may occupy the rear Such gradation facilitates better watching

(ii) Irrigated fruits should be planted close to the source of water and rainfed fruit trees be planted away from irrigation sources.
(iii) Fruits that ripen at the same time should be in continuous blocks.
(iv) High fertility portion of the orchard should be devoted to more paying and gross feeding fruit trees.

What are various planting systems?

There are five systems of planting in which the fruit trees are commonly planted These are as follows

(a) Square system
(b) Rectangular system
(c) Hexagonal or equilateral triangle system
(d) Quincunx or diagonal system
(e) Contour system.

(a) **Square system·**

This system of planting is the simplest and the most convenient to layout. Trees are set at the corners of a square formed by intersecting lengthwise parallel lines with crosswise parallel lines This system of planting is commonly adopted all over India. It has following advantages:

(i) Operations like ploughing, harrowing, cultivation, spraying, harvesting etc. become easy when trees are planted at equal distance from each other in regular lines
(ii) Irrigation channels can run straight
(iii) Better watching of the orchard is also possible as any tres-passers can be sighted even from the other end of the orchard.

(b) **Rectangular system**

This system is also commonly used in different parts of the world In this the trees are planted in straight rows running at right angles. The mehtod is similar, in all respects to square except that the plant to plant and row to row distances are not equal. The method of layout is similar to square system.

(c) **Hexagonal system**

This system is also known a equilateral triangle system as the trees are planted at the corners of equilateral triangles. Six trees

thus form a hexagon, with another tree at its centre. The main advantage of this system, is that by using it about 15 % more trees can be planted per hectare at any given diatance than by the square system. This plan can be usefully employed where land is expensive and very fertile with good available water supply.

(d) **Quincunx or diagonal system**

This system is the same as square system with the addition of a tree in the centre of each square, that is, at the points of diagonal cut In this case, the number of trees are almost double But the distance between the trees in the centre and at the corner is much reduced For this reason the central tree is usually not a permanent tree and is planted just to fill the central place This is known as a "Filler" Filler serves as a source of additional income till the main trees come into bearing It should be removed if it hinders the growth of main plants in any way Obivously fillers are planted when plant to plant distance is much and the plants are expected to come into bearing after a number of years. Examples of fillers are papaya or guava in mango orchards

(e) **Contour system**

This system is usually followed on the hills with high slopes

Distance of planting

Planting distance varies with the type of fruit plants to be grown Tall trees like mango, litchi, sapota, are normally, grown at a distance of 10 meters. Medium tall trees like orange, guava, apple, peach, plum are grown at a distance of 5 meters, while other plants like grape, banana, pineapple, papaya are planted at a still lesser diatance.

5.3 Precautions

- Make the orchard boundareis properly.
- Note directions, slope, contours of land precisely and draw a plan on paper
- Mark the base line properly before proceeding to layout the plan for planting

5.4 Materials required

(i) Long rope
(ii) Measuring tape
(iii) Wooden pegs

(iv) Lime dust
(v) Ranging rods
(vi) Dumpy level

5.5 Procedure

5.5a *Square system*

— Establish base line A1, B1 This base line should be parallel to the road, fence or adjacent road.
— Put stakes on A1 and B1
— Make right angles at A1 and B1 to impose the orchard squarly on the base
— Mark point C1 on the perpendicular line drawn at A1 with help of measuring tape
— Similarly, mark point A1 on the perpendicular line drawn at B1 with the help of measuring tape keeping in view that the lines A1 C1 and B1, D1 are equal By this way, the outside rows (A1B1, B1D1, D1C1, C1A1) are eatabilished
— Measure the rows at tree distances and fix stakes

5.5b *Rectangular system*

The procedure is the same as for square system except the row to row and plant to plant distance will vary

5.5c *Hexagonal or equlateral triangale system*

— Establish base line on one side of field as in square system
— Mark the base line at desired distance and fix the pegs.
— Make equilateral triangle on the base line.
— Mark the tops of all the triangles on the base line by a second line
— Join all the tops of the triangles. This will become the base line for the second line of plants.
— Similarly, mark the remaining plants of the orchard.

5 5d *Quincunx or diagonal system*

— Mark the plants as done in square system
— Join the four pegs forming a square.
— Join the oppiste plants by rope and mark it by lime dust
— Mark the points where the two diagonals meet.
— Put the peg at this point.

5.5e *Contour system*

— Mark the places on the same contour usıng Dumpy level Distance between contours will very dependıng upon the slop and the kınd of fruit tree to be planted.
— Connect the poınts havıng the same level by a lıne
— Plant trees along the contour gıvıng requıred spacıng.

5.6 **Observations**

The pupıl should record the followıng observations

Area of orchard = ... ha
Fruit to be grown:

Sl No	*System of Planing*	*Distance in Metres*		*Number of plants Planted*
		Row to Row	*Plant to Plant*	
1	2	3		4.

1 Square
2 Rectangular
3. Hexagonal
4 Quincunx
5 Contour

5.7 Calculations

The pupil should calculate the number of plants of different fruit crops per hectare with different system of planting by using the following formulae

Square and rectagular systems.

$$\text{No of plants required for 1 ha} = \frac{10{,}000 \text{ sq. m.}}{\text{row to row distance(m)} \times \text{plant to plant distance(m)}}$$

Hexagonal system

$$\text{No of plant required for 1 ha} = \frac{10{,}000 \text{ sq m}}{\frac{1}{2} \times \text{plant to plant distance(m)} \times \text{distance between 2 rows (m)}}$$

Quincunx system·

In this case the number of plants become double that of the square system

5.8 Expected behavioural outcome

The pupil acquires the following abilities to:

— know about orchard layout and planting systems,
— know about the advantages of planting with a particular system,
— know about the method of planting of trees in a particular system;
— calculate the number of plants required per hactare in a particular system for a particular fruit,
— plant the orchard using different systems of planting

The teacher should evaluate the pupil for the above abilities

5.9 Questions

(i) Why trees are planted in a particular system?
(ii) How the square system differs from a quincunx system?
(iii) What do you understand by filler crop?
(iv) Give the advantages of hexagonal system?
(v) What points would you consider while preparing the plant of the orchard?
(vi) What do you understand by orchard layout?
(vii) Give distance of planting in phalsa pine-apple and payaya.

6. Activity Unit

Digging and Filling of Pits

6.1 Instructional objectives

The pupil should be able to.
— know the size requirements of the pit,
— know the composition of soil mixture,
— dig and fill the pits

6.3 Relevant information

What should be the size of the pit?

It varies with the root system of the fruit plants By and large, fruit plants have tap root system except plants propagated by cutting and layers In general pits having cubical shape with 1 0 metre dimensions are dug for planting of fruit trees Size of the pit may vary from 30 cm to 100 cm depending upon the type of fruit plant

What is the composition of soil mixture for the pits?

It consists of soil, compost, 10 per cent BHC dust, bone meal/fish meal, superphosphate, sand, gravel etc

6.3 Precautions

— Use the digging tools carefully
— Use proper proportion of soil mixture

6.4 Materials required

(i) Pickaxe
(ii) Spade
(iii) Basket

(iv) Farm Yard manure/compost
(v) BHC Powder (10%)/Aldrex 5%
(vi) Bone meal/Fish meal
(vii) Super phosphate
(viii) Measuring tape
(ix) Rope
(x) Sand/Concrete
(xi) Dry leaves
(xii) Planting board

6.5 Procedure

— Measure the area.
— Make tentative layout on a piece of paper
— Locate the spots for digging pits
— Use planting board and keep the peg in the central notch.
— Insert two guiding pegs at both the ends of the planting board.
— Dig 1.0 m cubical pits using pick axe, spade etc preferably 3-4 weeks prior to planting
— Take 1/3 dug out surface soil and spread three baskets of compost and one basket of sand
— Spread 50 g. of 10% BHC dust and 1 0 kg of bone meal/ fish meal and 250 g of super phosphate over the soil and compost heap The proportion may vary from plant to plant
— Mix the entire material thoroughly.
— Spread 1 0 cm thick layer of dry leaves and one basket of gravel at the bottom of the pit in case drainage is not proper.
— Put soil till 1/3 pit is filled.
— Pour the soil mixture so that pit is completely filled higher than the ground level and dome shape is attained.
— Remove the board and the central peg for digging the pit

6.6 Calculations

The pupil should calculate the area of the pit.

6.7 Expected behavioural outcome

The pupil acquires the abilities to·
— know the size requirments of the pit;

— dig and fill the pit

The teacher should evaluate the pupil for the above abilities

6.8 Question

(i) Why do we use 10% BHC powder in the soil mixture?

(ii) Why do we put dry leaves and gravel at the bottom of the pit?

(iii) Why the planting board is used?

(iv) Why it is advisable to fill the pit higher than the ground level and leave it dome shaped?

7. Activity Unit

Selection of Plant Material, Planting and Transplanting

7.1 Instructional objectives

The pupil should be able to·

— acquire knowledge about various steps in planting,
— acquire knowledge about time and method of transplanting seedlings for root stocks in nursery bed and in pits,
— acquire knowledge about the precautions taken while selecting the plant material,
— know important points for selecting good plant material for planting in the orchard.

7 a 2 Selection of plant material

Selection of plant material

Why selection of plant material is important?

Quality of the produce and the ultimate success of the orchard depends upon the planting material selected at the time of establishment of orchard. Orchard is a long term proposition and if wrong or inferior type of plants are used then there will be waste of energy, resulting into uneconomic returns

How to select good planting materials?

Points to be considered while selecting good plant material are:

(1) Plants should be purchased from reliable sources such as Government agencies, research stations or reputed nurseries.

(ii) Should be of selected variety with good bearing and assured market
(iii) Larger number of varieties may not be selected
(iv) Vigorous and healthy plants of known parentage only should be selected.
(v) They should be free from pests and diseases
(vi) Very old and young plants should be avoided as in old plants mortality is more and young plants take long time for bearing.
(vii) Plants, which are one year old and of medium size of 60-75 cm height are ideal for planting
(viii) In grafted plants, the stock and scion should be of the same size

7 a.3 **Precautions**

— Select furit plants of established commercial varieties
— Plants should not be over aged, under aged, diseased or weak.
— Purchase plants only from reliable source
— Purchase 15% more plants than the required number to take care of possible casulities.
— Plant only after 2-3 good showers in rainy season.

7.a 4 **Materials required**

(i) Desired number of plants (grafted/budded)
(ii) Planting board
(iii) Pick axe
(iv) Spade
(v) Transplanting trowel
(vi) Wooden stakes (1 metre)
(vii) Secateur
(viii) Sutli or thread
(ix) Pruning saw
(x) Hatchet
(xi) Polythene sheets.
(xii) Pruning knife
(xiii) Watering can

7.a.5 **Procedure**

— Select disease free, vigorous and healthy plants of desired age and variety of fruit crop as suggested earlier.

7.b.2. **Planting**

What is planting?

Planting means putting plants in their permanent places in a new orchard or in the pits prepared for the purpose

What is the season of planting?

The season of planting varies with different fruits and local conditions There are three seasons of planting in India, (i) Monsoon (June-August), (ii)Spring (February-March), (iii) Winter

Monsoon season is considered to be the best season for planting evergreen fruit trees like citrus, mango and guava The roots develop properly. They need less irrigation than late planted plants. They can withstand the heat and dry winds. In areas with irrigation facilities, spring (February) planting is also done Trees planted in spring, establish roots in summer. Plants start growing as the weather warms up and during the rains put up a vigorous growth In heavy rainfall areas, planting may be done after the heavy rains are over

Deciduous trees may be planted during the dormant period in winter without shock. Care should be taken that planting is done before the growth starts, otherwise, trees suffer severely and are in a poor condition to face the next hot weather Early spring planting is usually favourable becuase the trees become established before the hot weather of late spring or early summer Bare rooted trees should not be planted until the soil is warm and the growing season is well begun Placing bare roots in a cold soil delays new root growth and may result in their decay

7 b.3 **Precautions**

- Remove the packing materials from the root ball.
- Keep the graft/bud union about 20 cm above the soil level.
- Keep the plant straight and stake immediately after planting
- Irrigate the plants if there is no rain after planting.
- Press the soil firmly and prevent irrigation water coming in contact with the stem.

7 b.4 **Materials required (Refer 7.a.4)**

7 b.5 **Procedure**

— Place the planting board in position with the help of the guide pegs near the filled pig
— Keep the stem of the plant into the contral notch.
— Remove the soil with *Khurpi* to accommodate ball of soil with the root system
— Firmly press the soil.
— Keep the soil level high near stem. portion and in the pit.
— Put a wooden stake and tie it loosely with the plant stem at 2-3 points.
— Irrigate, if there are no rains.
— Press the soil of the pit again after 2-3 days

7.c 2 **Transplanting**

What is transplanting?

Lifting the plant carefully from one place and planting it at another place is called transplanting.
Transplanting can be carried out both in young and old plants

Why transplanting is done?

Transplanting is done from seed beds or from primary to secondary nursery.

— so that roots may not go very deep in the soil, otherwise, lifting, packing and transportation of such plants becomes very difficult. Roots are injured during lifting resulting in mortality of plant;
— so that plants raised for root stocks in seed beds grow quickly in the nursery after transplanting as they get more space for their shoot and root growth,
— so that grown up valuable tree can be lifted from the place where it is not required and transplanted at a desired site.

7.c e **Precautions**

— Transplant during rainy season or in humid weather
— Irrigate the soil judiciously before lifting for transplanting.
— Prune the aged plants severely to avoid mortality.
— Provide covers to the transplanted plant to check loos of water from top
— Paint the cut end with Bordeaux paint.
— Transplant seedlings for root stock at proper spacing

(Mango 50 cm × 50 cm) in the nursery.
— Do not retain seedlings in the bed for longer time

7.c.4 **Materials (Refer 7.a.4)**

7.c 5 **Procedure**
— Irrigate the seedbed with water can
— Lift the young seedlings with the help of transplanting trowel
— Remove lower leaves
— Keep the seedlings in shade and sprinkle water over them.
— Take the seedlings to the planting site for transplanting.
— Transplant during evening hours or cloudy day
— Plant it in the prepared pit or narrow trench in the nursery bed at proper spacing for raising root socks (Mango 50 × cm)
— Irrigate after transplanting.

7.6 Observations

The pupil should record the following observations:
— percentage of mortality of plants transplanted or planted
— percentage of plants purchased from nurseries, found fit for planting
— casualities due to faulty handling of plants while planting and transplanting.

7.7 Calculations

$$\text{Percentage mertality} = \frac{\text{Number of plants survived}}{\text{Total number of plants planted}} \times 100$$

7.8 Expacted behavioural outcome

The pupil acquires the following abilities to
— know the different criteria for selecting the plant material for planting;
— plant properly with the use of the planting board,
— know various precautions while transplanting of seedlings and plants for root stock,
— do transplanting of fruit plants in the orchard and in nursery for root stocks

The teacher should evaluate the pupil for the above abilities

7.9 Questions

(i) What are the points to be considred while selecting the plant material for planting?

(ii) Why selecting of plant material is imporatnat?

(iii) State suitable time for planting of ever-green and deciduous trees?

(iv) Describe the use of planting board in locating the centre of pit

(v) Why transplanting is done in the evening or on a cloudy day?

(vi) Why leaves are removed from seedlings before transplanting?

(vii) Why graft/bud union point is kept above ground while planing?

8. Activity Unit

Potting and Repotting of Plants

8.1 Instructional objectives

The pupil should be able to:

- understand the meaning of potting, depotting and repotting,
- know the purpose of potting and repotting,
- understand the need for potting and repotting,
- learn th techniques of filling the pots, depotting and repotting;
- develop the skills of planting different plant species;
- learn the preparation planting mixture.

8.2 Relevant information

Meaning of potting, depotting and repotting

Potting is a process of planting of new plants in a pot with a suitable pot mixture for establishment. It is a simple operation but requires certain degree of skill and practice There are several demerits of pot culture The space and the quantity of growing media are limited and hence, are resticted. They are subjected to extremes of humidity and temperature, especially when placed in exposed situation Hence, the need for repotting

Depotting is a process of removal of estabilished plants from pots to provide the growing plant with more and fresh growing mixture

Repotting is a process of planting the depotted plants in a new pot mixture.

Purpose and need·

Potting is an horticulatural necessity, both in the rapid multiplication of plants and for effective beautification of gardens Pot

plants are easily handled and shifted to desired places In times of scarcity of water, large number of plants can be grown in pots than in the ground. Delicate plants can also be grown more conveniently in the pots

Techniques of pot preparations:

(a) **Prevision for drainage.** The first requisite of good potting is the provision for efficient drainage. The water supplied to the plant should pass out of the pot after wetting the soil thoroughly It should not be allowed to stagnate in the pot round about the roots For this purpose drainage holes are provided in the pots at the bottom The drainage of a pot is effected in a simple way For pots upto 10cm size, a single piece of crok (broken pot piece), is put against the drain hole, with its concave or hollow side turned towards the hole For larger sizes, a large crock is placed against each of the drain holes and some more pieces of crock are placed above them overlapping each other with their hollow sides all turned downwards These smaller pieces are than covered with a layer of broken pieces of crocks of the size of a pea Finally, the crocks are covered with a layer of coarse sand or coconut fibre to prevent fine soil from getting washed down into the drainage mete rial and clogging it For small pots upto 15 cm drainage to a depth of 2 cm will do. For a larger pot upto 25 cm, 4-5 cm depth of drainage may be necessary. Pots for orchids, which require perfect drainage, have 25 to 33% of their depth filled with crocks

(b) **Use of clean pots**: New pots should be soaked in water for about an hour Old pots should be scrubbed both inside and outside with the brush or coconut fibre and even washed in hot water to remove all dirt and mess Cleaning also removes remnants of past disease, fungus spores, etc But on no account should the pots be wetted immediately before use, as the new soil would stick to the pot and would interfere with aeration

(c) **Use of clean crocks:** Unclean crocks may infect the new plant with disease, apart from clogging problems

(d) **Use of suitable soil**: It is necessary that each kind of plant should be grown in a soil mixture which as best suited for it

(e) **Potting soil not to be quite dry.** The potting soil should be used in a moderately moist condition. A handful of soil pressed firmly should mould itself to be shape of the hand without dripping

moisture and should at the same time crumble when it is disturbed, without being so dry as to fall apart Dry soil cannot be easily worked with. Further, it will *not* be wetted entirely while being watered, as the water has tendency to run down lthe sides without moistening the dry soil

(f) **Pot firmly**. By firm potting is meant, pressing the soil in the pot to such an extent that the plant cannot be pulled out easily. The degree of firming depends upon the nature of planting material used. Soft wooded plants require less firm soil, while hard-wooded plants require greater firmness

(g) **Allowance of head space at the top for watering** After firming the soil, there should be 2 cm of space in case of smaller pots and 3–5 cms in case of larger pots

(h) **Wetting of soil before repotting**· The plant to be repotted may be watered two to three hours before repotting. Plants should never to repotting when the earth holding their roots is quite or nearly dry it seldom gets soaked afterwards, when surrounded with soil of a moist nature through which water passes readily, leaving the dry part to remain as before.

(i) **Do not use oversized or undersized pots:** It is necessary to use some judgement in choosing the size of the pot. If the pot it too large, there is uneconomical waste of resources and if too small, there is the danger of getting into root bound conditions.

(j) **Do not plant too deep**. Too deep planting is very harmful, especially to hard-wooded plants The shallow potting is like-wise injurious, as roots will not get a firm hold on the soil and will get shaken with every breath of wind It is always safe to plant in such a way that the old ball of earth is not placed lower than what it had been previously.

(k) **Remove to shade after potting**. After potting the plants should be removed to a shady place until root action commences afresh After they are established, they are gradually hardened by admitting more and more sun to them, before they are actually put in the open.

Preparation of pot mixtures

(a) **For planting cuttings**· Prepare the mixture by mixing thoroghly 2 parats loam, 3 parts leaf mould and 6 parts sand.

(b)**For Rose Plants:** Prepare the mixture by mixing thoroughly 4 parts loam, ½ part bonemeal, 6 parts decomposed Farm Yard manure and 4 parts sand.

(c) **For Fruit plants:** Prepare the mixture by thoroughly mixing 4 parts loam, 3 parts compost, 2 parts bonemeal and 2 parts sand.

8.3 Precautions

- Procure required materials well in time
- Select quality pots of required size
- Do not forget that you are handling delicate living plant material
- Do all the planting operation in shady situation of the nursery
- Attend to all the necessary after-potting care.

8.4 Materials required

(i) Pots
(ii) Broken pieces of pots (crocks), pebbles
(iii) Coarse sand/coconut fibre/dried leaves
(iv) Potting mixture-red earth, sand, compost
(v) Planting material (plant)
(vi) Secateur
(vii) Pruning knife.
(viii) Garden trowal
(ix) Dibbler.
(x) Khurpi.
(xi) Spade
(xii) Water can with rose.

8.5 Procedure

Filling of pots

- Select well baked and sound pots of the proper size(the size will depend on age of the plant and purpose)
- Wash the pot, both inside and outside, with clean water
- Place a large crock on the drainage hole Now put several smaller crocks to a depth of 3 to 5 cm, depending upon the size of the pot

— Put 2 to 3 layer of coarse sand or coconut fibre
— Fill the pot with a soil mixture (depending upon nature of plant/purpose) When half full, press the mixture firmly Continue filling up to the rim of the pot Press the potting mixture again, and finally fill and press mixture to a point where a room of 3 to 5 cm is left for holding water

Potting

— Use pots filled as described above for sowing seeds, potting of plants or planting cuttings.
— Scoop cut a hole in the centre of the pot.
— Keep the plant in the centre of the hole with roots well distributed in all directions Throw soil all round the plant and press soil firmly and uniformly Take care that planting is not done too deep.
— Irrigate the plant with watering can fitted with a fine rose nozzle.
— Place the potted plant in a cool shady place

Depotting

— Hold the plant with right hand between second and third finger and thumb along the side of the pot to remove the plant from the pot.
— Turn the pot upside down and tap gently on the edge of the earth. Take out the ball of earth from the pot carefully
— Prune the lower finger roots and remove some soil to reduce the ball of earth before putting the plant in the new pot

Repotting.

— Place the plant in the new pot mixture by scooping out little quantity of soil
— Spread some more quantity of pot mixture over the roots; press it gantly
— Water the plant with a rose head water can
— Place the potted plant in a cool shady place.

8.6 **Observations**

The pupil should record the following observations

Sl. No	*Name of Crop/*	*Type of Planting Material*	*Type of Pot Used*	*Size of Pot*	*Rate of Constituents of potting mixture*	*Remarks*
1	2.	3.	4	5	6	7
1						
2						
3						
4						

8.7 Expected behavioural outcome

The pupil acquires the following abilities to.

— know the techniques of preparation of pots (drainage, filling),
— know the method of planting of plants of various types,
— know the method of depotting and repotting,
— prepare pot mixtures for different types of plants.

The pupil should evaluate the people for the above abilities.

8.8 Questions

(i) Why is pot culture necessary?
(ii) Why is a new pot immersed in water before it is used?
(iii) Why are crocks and pots to be cleaned? How do you do this?
(iv) What is the importance of drainage in pot? Write the procedure for obtaining good drainage
(v) Describe in details the mehtod of filling of pots
(vi) Why is the head space left while filling the pot mixture?
(vii) Name different pot mixture indicating their uses
(viii) Describe the need for firming the mixture in the pots How does it differ for herbaceous and woody plants?

9. **Activity Unit**

Care of Young Plants

9.1 Instructional objectives

The pupil should be able to

— know different stages of plant growth,
— acquire knowledge of training and pruning of young plants,
— know about water sprouts and unwanted growth of root stock,
— acquire knowledge of irrigation and manuring of young plants;
— acquire knowledge about protection of young plants from high winds, important insects, pests and diseases

9.2 Relevant information

Why care is needed for young plants?

— Young plants are soft and succulent.
— Young plants may break up or bend at the graft union point
— Young plants are succeptible to attack by insect pests and diseases
— Root system of young plants may be injured due to faulty interculture operations.
— Proper training of young plants in early stages will ensure good frame work later
— Plants being perennials, their future growth depends on the care given for manuring and irrigation in early stages

Why and how care is to be given?

— Plants should be protected from wind by providing stakes for support besides already planted wind breaks.

— Flowers are removes from plants upto the age of 4 years to enable proper development of the plant during pre-bearing period.
— Remove water sprouts, sprouts from root stock and dead shoots
— Do not allow sprouts on the plant upto an height of 60 cm
— Select 3-4 well developed shoots at 60 cm height for getting good frame work
— Use mulch material in the prepared basins to minimise water loss in summer months
— Remove budding or grafting tapes from the plant If left over, they will girdle the plant and eventually kill it

9.3 Precautions

— Stake the young plants immediately after planting and tie loosely with coir string.
— Avoid deep hoeing near the plant otherwise roots may be injured.
— Adopt timely plant protection measures.
— Prevent water stagnation at the base of plants by raising soil about 30 cm away from plant
— Grow inter crops away from the root zone of plants

9.4 Materials required

(1) Wooden stakes or bamboo stakes coated with coal tar.
(2) Secateur
(3) Pruning knife
(4)Khurpi (weeding hook)
(5) Hand rake
(6) Watering can
(7) Spade.
(8) Pick-axe
(9) Pruning saw
(10) Insecticides and fungicides
(11) Sprayer (knap-sack or gator rocking type
(12) Rotary duster
(13) Sutli or thread or coir
(14) Mulch materials (Paddy straw or wheat straw or polythene)

9.5 Procedure

— Insert the stakes in the soil near the plants
— Tie the plants with thread or sutli loosely at 2-3 places for keeping the plants erect.
— Remove the budding or grafting tape from grafted or budded plant after they establish and put out new growth.
— Apply required quantity of manures and fertilizers in soil, just in the area, covered by roots
— Drain out standing rain water from the orchard soil by digging open drains.
— Keep the soil level high around the plant by forming a raised circular ridge.
— Irrigate the plants at an interval of 3-4 days in summer months and 8-10 days in winter months.
— Spread mulch in the prepared basin in summer month to minimise water loss.
— Prune side branches or shoots with secateur upto 60 cm height, then allow branches above it to give a good frame work with 4-5 main scaffold branches
— Remove all sprouts from time to time from below the graft union
— Remove dead portion from the plants
— Apply Bordeux paint over the cut surface
— Adopt plant protection measures for the control of insects and diseases.
— Remove flowers from the young plants upto 4 years of age
— Replace the dead plants with the plants of the same variety
— Apply Bordeux paste on the stem portion upto the height of about 30 cm to avoid fungal disease infection on the stem

9.6 Observations

The pupil should be able to record the following observation:
— Effect of removal of sprouts below the graft joint on plant growth
— Effect of mulching on growth of plants
— Effect of proper drainage on growth of plants.

9.7 Expected behavioural outcome

The pupil acquires the following abilities to
— recognise water sprouts and sprouts arisisng from root

stock and their timely removal,
- stake the plants and prune the unwanted growth from the young plants,
- understand the effect of proper irrigation, manuring and mulching on plant growth.
- observe and recognise the attack of insects, pests and diseases on young plants and to take effective plant protection measures.

The teacher should evaluate the pupil for he above abilities

9.8 Questions

(i) Why do young plants need staking?
(ii) Why should flowers be removed from the young plants?
(iii) What happens if budding or grafting tape is not removed from the grafted or budded plants?
(iv) Why are mulches used?
(v) Why branching in young plant is not allowed upto the height of 60 cm?
(vi) How are young plants protected from temporary water logging situation?
(vii) Why Bordeux paste is applied to the cut ends of stems?

10. **Activity Unit**

Protection of Plant from High and Low Tempreature Damage

10.1 Instructional objectives

The pupil should be able to.

— know different methods for protection of plants from high and low temperatures;

— acquire knowledge about the adverse effects of high and low temperature on the young and bearing trees of the locality

10a. Sub-unit: Protection of Plants from High Tempreature Damage

10a 2 Relevant information

What are the damages caused by high temperature?

— In summber the leaves, new shoots, branches, flowers and fruits are exposed to sun and high temperature High temperature is generally more harmful when accompanied by low humidity This causes excessive transpiration and wilting of leaves and twigs

— The ability of plants to withstand such condition varies greatly with the species; e.g banana is more sensitive than guava plants

— Young trees are affected more than the old plants

— High temperature and low humidity is a limiting factor in case of certain fruits like banana.

— Sun burn of the leaves, fruits (pineaple) and bark is some-times a serious factor. Plants planted in a east and

south aspect are more affected than in other direction as they are exposed to sunlight for longer time.
— Flowering and fruit set are adversly affected by high temperature as in mango or mandarin

10a.3 Precautions

— Plant thick and tall growing trees for wind breaks at the time of orchard establishment
— Severe pruning of trees be avoided during summer season
— Adopt protection measure before the commencement of high temperature

10a.4 Materials required

(1) Bamboo mats or straw thatches
(2) Hydrated lime
(3) Wooden stakes
(4) Mulches (straw of paddy or wheat or dry leaves).

10a.5 Procedure

— White wash the main stem and also the small branches and young plant shoots at the beginning of summer season.
— Insert bamboo pegs on four sides and cover the top of the young plants leaving north side open Irrigate properly to have more humidity in the orchard
— Spread the mulch in the basins of the young and old trees of the orchard
— Provide grass over to fruits as in pineapple

10a.6 Observation

— Record the sun burning effects if any on the leaves, young shoots and fruits
— Observe the number of flower and fruit fall due to high temperature e.g mango and citrus fruits
— Observe the effect on growth of fruits and the damage such as sun scald
— Compare the growth of thatched young plants with the unthatched plant of the orchard

10a.7 Expected behavioural outcome

The pupil acquires the following abilities to

— protect the young and bearing fruit plants from high temperatures,

— record the damages caused by the high temperatures to the young and bearing trees,

— know about the effective methods of protection against high temperature.

The teachers should evaluate the pupil for the above abilities.

10a.8. Questions

(i) Name various damages done by high temperature to young and bearing trees.

(ii) What methods can be suggested for protection against high temperature?

(iii) Why in north, India, fruit plants are damaged more by temperature than in South India?

(iv) How does white washing on the stem protect the plant from high temperature?

(v) Why south-east side is kept open while providing covers to plants?

(iv) Why is aspect of planting fruit trees important?

10b. Sub-unit: Protection of Plants from Low Temperature Damage

10b.2 Relevent information

What are effects of low temperature on plants?

— In India especially in the hills and plains of north India frost occurs either during the winter or in early spring.

— Low temperature effects are due to freeze and frost occurrence in the area.

— Low temperatures (Freezing) occuring either during the rest period of fruit plants or afterwards, cause damage to roots, stems and buds. At lower tempertures, water is withdrawm from the protoplasm and ice is formed in the intercellular spaces. If this process proceeds beyond

critical limits the protoplasm of the cells disintegrates and dies from loss of water

— Frost causes damage to the newly opened blossoms (flowers) of fruit trees, to young growth and newly set plants. Frost occurs when there is suficient moisture in the air and the temperature of the exposed surfaces falls below 32°F.

— Important types of injuries noted in fruit plants are as follows.

(1) *Black heart*—This is mostly in nursery plants Inner wood becomes dark

(2) *Splitting of bark*—Caused due to severe frost occurrence. This may extend to trunk and branches.

(3) *Killing of shoots and young branches*— Sub tropical fruits may be damaged by frost in spring If there is early growth and flowering in fruits like mango, flowers may be killed while in others like citrus and papaya even fruits are injured.

(4) *Frost damage*—Evergreen trees are damaged heavily but deciduous trees shed their leaves and are not normally damaged In young fruit plants, the damage is very severe.

10b.3 **Precautions**

— Delicate young fruit plants be planted in the inner side of orchard

— Wind-breaks should be planted in time on west and north side of orchard.

— After removing the wrapping material, wrapped portions should be given a coating of white-wash.

— Plants of frost tolerant varieties be given preference for planting in the new orchard.

— Apply adequate manures and fertilizers to make the plants stronger and more tolerant

10b.4 **Materials required**

(1) Corn stalk or dry grass

(2) Bamboo or kans (*Saccharum spontaneum)* or dry maize or jower shoots.

(3) Lime and brush
(4) Coir or suth
(5) Waste material (leaves, dry branches)

10b.5 Procedure

— Irrigate orchards regularly during frost periods
— Burn waste materials (dry leaves and twigs) in orchards (10-12 places in one hectare).
— Cover the trunk with corn stalks or grass
— Cover the young plants with bamboo mats or dry maize stalk or kans on three sides leaving the south east side exposed for light and sun
— Plants quick growing green manuring crop around young plants to provide protection.

10b.6 Observations

(i) Compare the effectiveness of materials used for protection against frost.
(ii) Observe the efficiency of material used for protection of young plants against frost

10b.7 Expected behavioural outcome

The pupil acquires the following abilities to
— protect young and bearing plants from low temperatures;
— note the damages caused by low temperatures;
— differentiate between frost and freeze,
— evaluate the efficiency of methods adopted for protection against low temperature

The teacher should evaluate the pupil for the above abilities.

10b.8 Questions

(i) Describe the nature of damage caused by low temperatures to young and bearing trees
(ii) Differentiate between frost and freeze
(iii) Why are young and weak plants damaged more by low temperatue than old and healthy plants?
(iv) Name various methods of protection of plants against low temperature?

11. Activity Unit

Study of Ill-Effects of Water Logging and Methods of Overcoming them

11.1 Instructional objectives

The pupil should be able to

— know about the ill-effects of water logging;
— identify the plants suffering from water logging;
— know the various methods of overcoming the water logging conditions

11.2 Relevant information?

What is waterlogging?

It is a condition in which the water accumulates in the soil. Due to this the roots of the trees growing in it are deprived of proper aeration and hence are unable to absorb water and nutrients for want of oxygen There is accumulation of carbon dioxide in the soil. The leaves become yellow and in severe cases the plant dies

Why waterlogging?

This situation arises due to excessive irrigation, improper drainage and high water table in the soils

11.3 Procautions

Provide proper drainage in the orchard Take proper measures to aviod erosion of soil.

11.4 Materials required

(i) Spade
(ii) Pick-axe
(iii) Drainage pipes to be used under the roads, paths, etc

11.5 Procedure

— Properly level the land before planting the trees
— Dig main drainage channels according to the topography of the field
— Provide secondary drainage channels according to the layout of the orchard
— Prepare the tertiary drainage channels where-ever required for effective drainage
— Check soil erosion at the end of the main drainage channels by adopting suitable measure

11.6 Observations

The pupil should take and record the following observations:

(i) Symtoms of water logging in fruit plants
(a) Banana
(b) Papaya Observe symptoms of foliage and condition of roots
(ii) Growth of fruit plants in well drained area: (Papaya and Banana)
  (a) Vegetative growth
  (b) Flowering
  (c) Fruiting

11.7 Expected behavioural outcome

The pupil acquires the following abilities to·
— know about the ill effects of water logging;
— identify the plants suffering from water-logging,
— know the various methods of overcoming water logging conditions.

The teacher should evaluate the pupil for the above abilities.

11.8 Questions

(i) What do you understand by water logging?
(ii) How do you identify a plant suffering from water logging?
(iii) What precautions are necessary to avoid water-logging in the orchard?
(v) Name the fruit crops which are more sensitive to water logging?
(iv) What points would you consider while preparing drainage channels in the orchard?

12 Activity Unit

Application of Manures and Fertilizers to Fruit Crops

12.1 Instructional objectives:

The pupil should be able to.

- differentiate between organic manures and chemical fertilizers;
- know the differences in the nutritional composition and availability of nutrients in organic manures and fertilizers,
- know about the time of application of manures and fertilizers,
- learn the method of application of manures and fertilizers

12.2 Relevant information

What are manures?

Manures are complex organic compounds containing limited amount of nutrients. These nutrients are present in an unavailable form. They are released only after decomposition by micro-organisms Hence, these nutrients are not lost by leaching

The structure of the soil is improved by the addition of organic matter Farm yard manure, oil cakes, fish meal-are are some of the organic manures generally used in fruit production

What are chemical fertilizers?

Chemical fertilizers are simple or complex inorganic compounds which contain plant nutrients in fairly large amounts and in readily available (soluble) form. Urea, ammonium sulphate, supperphosphate and muriate of potash are some important chemical fertilizers used in fruit production The addition of the chemical fertilizers does not improve the structure of the soil.

Time of application of the manures and fertilizers

Organic manures are complex organic compounds which need microbial degradation before the release of nutrients in an available form Hence, they should be applied 2-3 months in advance of flowering or vegetative growth

Nutrients are present in a readily available form in chemical fertilizers Hence, they may be applied a work before flowering or vegetative growth

Nitrogen occurs in highly soluble form To avoid its leaching it should be applied in 2-4 split doses P and K which are first fixed and then slowly released can be applied in one single does

Method of application

The following are the two methods of application of manures and fertilizers

(i) Soil application
(ii) Foliar application.

(i) **Soil application**

In case of perennial fruit crops ring placement method is used for the application of fertilizers In this method, a ring 15-20 cm wide is opened in the drip zone, and the fertilizers are applied and mixed in the soil In this region, a large number of feeding roots are present, and hence there will be maximum absorption and utilization of nutrients applied

(ii) **Foliar application**

The plants can readily absorb the nutrients which are sprayed on the leaves This method of application of nutrients is done to correct micro-nutrient deficiencies. This method of application of nutrients is/not so efficient.

12.6 Precautions

— Identify fertilizers properly
— Know the nutrient composition of fertilizers and calculate quantities to be applied
— Avoid damage to roots at the time of manuring
— Use nutrient solutions for foliar sprays to avoid damage to the leaves

12.4 Materials Required

(i) Farm yard manure
(ii) Urea (with low biuret content)
(iii) Super phosphate
(iv) Potassium sulphate
(v) Composite trace element solution
(vi) Tools for digging
(vii) Sprayer

12.5 Procedure

Soil application of fertilizers

— Prepare a ring 15-20 cm wide and 20 cm deep around a tree along the drip line
— Mix the fertilizers according to the recommendations
— Place the fertilizer mixture in the ring and cover with soil.

Foliar application of micro-nutrient

— Procure commercially available trace-elements, mix and spray to the citrus plants showing deficiency symptoms of Zn, Cu and Mn.

12.6 Observations

The pupil should record the following observations.

Characters	Plot 'A' (Manured/sprayed)	Plot 'B' (Control)
(i) Plant height		
(ii) Spread		
iii) Yield (No of fruits)		
(iv) Appearance of tree (foliage)		

12.7 Expected behavioural outcome

The pupil acquires the following abilities to:

— differentiate between organic manure and chemical fertilizers,
— know the nutrient composition and their availability in different manures and fertilizers;

— know the time and method of application of manures and fertilizers to fruit plants.

The teacher should evaluate the pupil for the above abilities.

12.8 Questions

(i) Inspite of limited nutrient content organic manures are a must for fruit production, why?

(ii) Why nitrogen should be applied in split doses?

(iii) Under what circumstances do you take up foliar feeding of plants?

(iv) Nutrients in organic manures are less susceptible to leaching, why?

13. Activity Unit

Study of Nitrogen, Phosphorus and Potassium Deficiency Symptoms in Fruit Crops

13.1 Instructional Objectives

The pupil should be able to;

- understand the role of important elements in the growth and production of fruit plants;
- induce NPK deficiency in fruit plants,
- study NPK deficiency symptoms in fruit plants,

13.2 Relevant Information

Importance of essential elements

Plants need adequate supply of 16 essential elements for their normal growth and production When they are available in inadequate or insufficient quantities, they express signs of 'Hunger' in the form of deficiency symptoms These are mostly exhibited in the leaves. There will be reduction in the growth and yield of the affected plants.

Deficiency symptoms

Nitrogen

Nitrogen deficiency is observed in leaves They become pale green or yellow. As the element is mobile the yellowing first appears in older leaves. Later, it spreads to younger leaves.

Phosphorus

Phosphorus deficiency results in the production of purplish leaves

Potassium

Potash deficiency shows up in the form of brown or necrotic patches in the leaf margins which gradually extend to the midrib, imparting a kind of 'Burnt' look

The importance of the study of deficiency symptoms

The study of dificiency symptoms will help to.

- differentiate the damages caused by pests and disease from deficiency symptoms;
- take up proper corrective measures to improve the yield and quality

How to correct the deficiencies?

By applying various organic and inorganic fetilizers in appropriate quantities

- Nitrogen is applied in the form of Farm Yard Manure and inorganic fertilizers such as Urea, ammonium sulphate, ammonium chloride.
- Phosphorus is applied in the form of phosphate (super-phosphate, triple super rock phosphate and diammonium phosphate and any complex fertilizer which contains phosphorus
- Potash is applied in the form of sulphate or chloride (muriate of potash) and also in the form of complex fertilizers

How to apply the difficient nutrients?

Best results are obtained by the soil application of manures and fertilizers. However, in acute cases, the foliar spray of the nutrients will give immediate recovery

Hoagland and Arnon (1938) solution and its composition

Hoagland and Amon solution is a nutrient solution used for growing of plants in solution/sand culture for the development of deficiency symptoms

The composition of the solution is indicated below

(i) 0 001	M KH_2PO_4	
(ii) 0.005	M $KHNO_3$	
(iii) 0 005	M $Ca(NO_3)2$	Culture solution
(iv) 0 002	M $MgSO_4$	

(v) One millilitre of 0.5% of ferric tartarate per litre of culture solution.

(vi) 2.5 g H_3BO_3, 1.5 g $MnCl_2$ $4H_2O$, 0.10 g $ZnCl_2$, 0.05 g $CuCl_2$ $2H_2O$ and 0.05 g MoO_3 dissolved in one litre of distilled water

One millilitre of this solution has to be added to each litre of the culture solution.

13.3 Precautions

— The sand used for raising plants should be free from plant nutrients
— The plastic or glazed porcelain pots used for raising plants should have a drainage hold at the bottom
— The pH of the medium should be maintained around 6-8 by frequent check

13.4 Materials Required

(i) Plastic or glazed porcelain pots
(ii) White sand
(iii) Chemicals for the preparation of Hoagland solution
(iv) Seeds of 2 crops (Papaya and Maize)
(v) Distilled water

13.5 Procedure

— Weigh about 1 kg of mutrient free sand in 32 plastic or glazed porcelain pots.
— Sow 2-6 seeds in each pot
— Add distilled water to keep the sand moist.
— Add distilled water only, till seeds sprout in all the pots.
— Maintain one seedling of papaya per pot and 3 maize seedlings/pot
— Start applying Hoagland solution as per the following schedule

Treatments.

(i) N deficient Hoagland solution
(ii) P deficient Hoagland solution
(iii) K deficient Hoagland solution
(iv) Hoagland solution (complete)

Crops 2 · (i) Papaya
(ii) Maize

Replications . 20

- Add same amount of Hoagland solution in all the treatments and in all the crops
- Continue to add distilled water for 45 days following sowing
- Repeat addition of Hoagland solution as mentioned above, after 20 days of first application

13.6 Observations

The pupil should study the plants and record observations on the following parameters·

Plant Character stics	*Crop*	Treatment			*Control Hoagland solution (complete)*
		N-deficient	*P-deficient*	*K-deficent*	
1	2	3	4	5	6
(i) Plant height	Papaya Maize				
(ii) Leaf colour	Papaya Maize				
(iii) Weight of plants	Papaya Maize				

Note. In addition to conducting this study the pupil will observe/ study symptoms of NPK deficiency in other fruit crops such as grapevine, guava and citrus fruits in the institution orchard or during field visits.

13.5 Expected behavioural outcome

The pupil acquires the following abilities to

— prepare Hoagland solution,
— raise plants successfully in sand culture,
— undertake studies on the expression of nutrient deficiencies in crop plants,
— identify NPK deficiency symptoms in fruit plants visually

The teacher should evaluate the pupil for the above abilities

13.8 Questions

(i) What is a deficiency symptom?
(ii) How do you differentiate deficiency symptoms due to deficiency of N, P and K?
(iii) Why N deficient plants develop yellow leaves?
(iv) What is Hoagland solution? What is its importance?
(v) Tick the right answer
  (a) Deficiency of N appears first in young/old leave
  (b) Deficiency of P appears first in young/old leave
  (c) Deficiency of K appears first in young/old leave.

14. Activity Unit

Irrigation of Orchards–Method and Timing

14.1 Instructional objectives

— The pupil should be able to
— know the importance of orchard irrigation;
— know the different systems of orchard irrigation;
— learn different methods to determine the time of irrigation,
— practise methods of surface irrigation,

14.2 Relevant information

What is irrigation?

The artificial supply of water to support plant growth and production in absence of adequate supply of water through rainfall is known as irrigation

Importance of irrigation

Plants need adequate supply of water for their normal growth and production. Where there is shortage of water, particularly during critical stages like flowering and fruiting, there can be drastic reduction in yield Hence, the necessity of irrigation to make up this dificiency of water

Systems of Irrigation

There are four major systems of irrigation mentioned as below·

(i) Surface irrigation
  (a) flooding
  (b) basin method
  (c) furrow method
(ii) Sub-surface irrigation

(iii) Overhead or sprinkler irrigation
(iv) Drip or trickle irrigation

Time of Irrigation

For maximum utilization of water, it is very important to ditermine the critical time and method of irrigation i e togive irrigation only when it is absolutely necessary, and apply only the required amount of water. This can be done by critical observations of the plant and changes in the available moisture in the soil

14.3 Precautions

— Devise your irrigation methods to ensure maximum utilization of water.
— Decide irrigation method in relation to varying orchars conditions.
— Know the water requirements of plants and avoid excess irrigation
— Know the soil properties to decide the irrigation method
— Know the critical stage of plant growth to ensure maximum utilization of water
— Know the drainage capacity of the soil to determine method of irrigation.

14.4 Materials Required

(i) Screw auger
(ii) Core sampler
(iii) Tube auger
(iv) Tensio meters
(v) Gypsum blocks
(vi) Physical balance
(vii) Moisture cans
(viii) Pipe lines
(ix) Rubber hose
(x) Spade
(xi) Measuring tape

14.5 Procedure

(i) *Flooding*

— Follow this mehhod if the land is flat and levelled and plenty of water is available

— Prepare plots of suitable size as per topography of the land and age of the plants
— Raise 9-10 cm soil along borders of the plots to make ridges for holding irrigation water
— Allow the water into the plot upto a desired level, then divert the water to another plot

(ii) *Basin method*

— Prepare basins of desired size and shape (circular, rectangular, square) around each plant depending upon age of the plants and topography of the land.
— Make 9-10 cm high ridge along edge of the basin
— Raise some soil around the stem of the plant to avoid direct contact of stem with irrigation water
— Saturate the basin with water from the irrigation channel

(iii) *Furrow system*

— Open 20-30 cm deep furrows on either side of the plant at proper distance depending upon age and spread of the plant
— Restrict the furrow length to 80-100 cm only to avoid wastage of irrigation water

Overhead of sprinkler irrigation

In this system water is led through the pipes and finally released to the atmosphere in the form of spray through various types of nozzels. This is much more efficient system as compared to the previous methods The loss of water by seepage and evaporation are avoided. This is an ideal system for hilly regions where other system cannot be used

Sub-surface irrigation

In this system, the water is led into underground perforated pipes The water slowly reaches the root regions by the upward capillary movement. This system of irrigation is not commonly practised under our conditions.

Drip or trickle irrigation

In this system water is led through plastic pipes and finally let out through mechanical devices called emitters There is direct and continuous wetting of the root region

This system ensures the highest water use efficiency and it is quite ideal for perennial fruit crops under arid and semi-arid conditions.

Soil moisture changes

To determine the timing of irrigation it is essential to study the changes in the soil moisture by determining field capacity and permanent wilting point of the soil samples by gravimetric method Set up tensio-meters in the field to monitor changes in moisture level to determine time of irrigation

14.6 **Observations**

The pupil should observe/record the following

a The system/method of irrigation in a particular location,
b. Changess in the available moisture in the soil;
c Observation on the response of plants to irrigation with the;
   i Determination of soil moisture content by gra vimetric method
   ii. Determination of field capacity
   iii Determination of permanant wilting point
   iv. Use of tensiometers for scheduling irrigation

Table: Observations on the Irrigation of Fruit Plants

Soil Characters			*Crop*	*Age of the tree*	*System of irrigation*	*Amount of irrigation given in acre inches*	*Condition of the plant*
Texture (a)	*Field capacity* (b)	*Permanent wilting point* (c)					
1			2	3	4	5	6

14.7 Calculations

1. Moisture percentage (PW)

$$PW = \frac{WS_1 \; WS_2}{WS_2} \times 100$$

WS_1 = weight of the soil sample before oven drying.

WS_2 = weight of the soil sample after oven drying at 105°C

Note One acre inch is the volume of water required to cover one acre upto a depth of 1". The total volume of water required is 3630 cubic feet

14.8 Expected behavioural outcome

The pupil acquires the following abilities to.

— understand different systems/methods of orchard irrigation;
— know the relative merits and demerits of different methods of irrigation,
— know methods to determine the timing of irrigation;
— know methods to observe the changes in the soil moisture;
— practise surface irrigation methods

The teacher should evaluate the pupil for the above abilities.

14.9 Questions

(i) What is irrigation?
(ii) Drip irrigation is highly suited to arid regions, How?
(iii) Mention plant characters which you use to dicide the time of irrigation
(iv) What is tensiometer? Mention its use
(v) Sprinkler system is ideal for hilly regions, why?

15 Activity Unit

Study of Common Weeds

15.1 Instructional Objectives

The pupil should be able to:

— identify the weeds common to the area;
— have knowledge regarding relationship between weeds and the environment,
— know the weeds specific to various fruit crops;
— know the weeds specific to certain locations,
— adopt broad measures to control the weeds.

15.2 Relevant Information

What is a weed?

Any plant growing out of place is a weed

Types of weeds

The weeds may be crop specific or season specific i e annual, biennial and perennial weeds

Identification and preparation of herbarium

It is always good to have collection of common weeds of the locality. A herbarium shall always be a handy tool for reference

Note: For details, refer to relevant mannuals.

15.3 Precautions

Collect speciman of each common type of weeds in a square meter area and note the type of soil, main fruit crop and season

15.4 Materials Required

For collection and identification of weeds

(i) Field note-book
(ii) Old newspaper sheets
(iii) Collection bag
(iv) Herbanium sheets
(v) Heavy material for pressing
(vi) Stiching material/adhesive

15.5 Proceduare

(a) *For collection of weeds*

— Note specific field/locality from which weeds are collected
— Find out crop association/immediate environment where weeds are collected
— Find out local names of the weeds collected
— Determine whether weed is major or minor according to damage made or spread (area covered).

(b) *For identification of weeds*

— Select fresh specimen having all important parts of the plant
— Spread the specimen in its natural from on a sheet of paper which can absorb moisture (i.e blotting paper) and put in between two smooth surfaces pressed tightly till it becomes dry
— Change the paper every 6-8 hours to avoid fungal attack and repress the speciman.
— Press the specimen on a herbarium sheet available in the market.
— Note down the following on the prepared sheet at a sufficient uncovered space or below the specimen.
Common name
Local name
Botanical name
Date of collection
Growth behaviour
Site of collection
Specific fruit crop condition (full grown or newly planted

crop, or the crop in its vegetative phase of growth) in relation to weed growth

— Select one square meter area for observing seed density by dry matter weight.

(c) *For weed control*

— Observe the tillage practice followed in specific fruit garden and note the occurence of weeds

— If the orchard is fully covering the soil by shade this may also be noted.

15.6 **Observations**

The pupil should be able to observe and record the following

(a) *For collection of weeds*

Specific plot/locality from which weeds collected	*Crop Association/ immediate environment where weeds found*	*Local/Common names of the weeds collected*	*Wheather weed is major or minor* / *Damage/spread*	*Any other relevant information*
1	2.	3	4	5

Plot No

Date of observation	*Interval from previous Observation*	*Weeds Found*			*Fruit Crop*	
		Kind (a)	*Population (b)*	*Stage (c)*	*Age (a)*	*Spread (area) (b)*
1	2	3.			4	

(b) *For identification of weeds*

The pupil should see the herbarium already developed by the senior students or by the teacher concerned.

(c) *For weed control*

The pupil should record the following

(A) Weed behaviour as affected by various crop husbandry practices, orchard management.

(B) Identification of weeds for their possible use after removal

Use	*Name and Weed*	*Special Notes*
Green manure Compost Animal fodder Human food Medicine Narcotics Subsidiary fuel Thatching Any other		

15.7 Expected Behavioural Outcome

The pupil acquires the following abilities to:

— select representative specimen of weeds;
— preserve weed specimens in herbarium;
— collect requisite information for each specimen;
— find out extent of damage caused by weeds;
— find out extent of spread of weed,
— identify weeds in relation to crop;
— identify the weeds for their possible use after removal.

The teacher should evaluate the pupil for the above abilities

15.8 Questions

1 Name two most important weeds of your area in relation to soil

2 Fill in the blanks·

. . is an important weed of . . . crop
. . . is an important weed of . . . season
. . . . . is an important weed of . irrigated soil

3 (i) How herbarium is useful for the pupil?
(ii) Why complete drying of weeds is essential before its actual pasting in the herbarium?

4 Name five monocotyledonous weeds.

5. Name five leguminous weeds

6. Which of the following method is better to estimate weed infestation of the field? Explain the reason.
(a) Weed count; (b) Weed weight (dry matter)

7. Name five weeds which can be used as animal fodder

8. Name five weeds which can be used for medicinal purposes.

16. **Activity Unit**

Training of Fruit Plants

16.1 Insturctional objectives

The pupil should be able to.

— know about the growth habit of plant i e tree, bush, creeper etc,
— know about bearing habits of plant,
— understand the effect of temperature and light on growth of plant;
— understand the various systems of training the plants according to their habit of growth;
— know the various cultural operations to be carried out under various system of training the plants,
— undertake training in some of the fruit plants.

Relevant information

What is training?

When a plant is made to grow, with or without support, in a desired fashion, by pruning some of its parts, with a view to giving the plant a frame work, the operation is called "Training"

Why training?

The fruit plants, when left to themselves may grow, at times, wild and may not bear satisfactory crop, unless trained to a specific form The untrained plants may pose problem in undertaking day-today operations i e., interculture, irrigation, plant protection, harvesting etc. There may not be proper aeration in the orchard, good penetration of light to various parts of the plants and easiness in supervision Also there may be imbalanced distribution of fruit bearing parts on the main limbs of the tree.

When to train?

It is vary essential to give proper attention to the training of plants right from planting. It is only during the first 2-3 years of plant life that the permanent frame work is built up and individual tree hygine is maintained with less cost.

Types of training

It is also important to decide the height of the first main branch to be maintained straight from the ground level and supported by stakes If the main branches are retained or induced to grow within 75 cm from the ground, the tree is known as 'low headed'. But if the branches are encouraged at 1.25 meter or higher, it is called 'high headed' training. Under tropical conditions, high headed training is not desirable, except under the conditions where the land is to be retained under hort-pastural condition and the animals are to be allowed for grazing.Very high headed trees are prone to high velocity winds and damage to main trunk by sun scaled, whereas low headed trees come to bearing comparatively much earlier and are able to sustain stormy winds efficiently. It is also easier to perform operation like spraying, harvesting etc

Systems of training of fruit trees

In training, it is very important to form the main frame work of a tree In this procedure, two to four main branches are encouraged, at wider distance and distributed at different directions, specially the branches are spaced at about six inches (15 cm) apart. If two or more branches are encouraged from one place and that too at narrow angle, they form a bad crotch and mostly break at common joint. For an efficient training, considering the natural habit of plants, commonly the following systems are adopted. The systems of training vine crops differ and are not discussed here

(i) *Central Leader*. In this, system, the main stem of the tree is allowed to grow straight from the surface of the soil to the top of the tree, which is called a central axis and smaller side branches grow from it in various directions Such trees grow tall,but bear fruits mostly near the top The lower branches go on becoming less vigorous and less fruitful.

(ii) In this system, the main stem of the trees is allowed to grow at a certain desired height and the top is headed to

induce lateral branches resulting in low headed and keeping the centre open, mostly of an inverted cone shape or a vase shape In this system, full sunshine reaches to each branch, the crop is borne closer to the ground It greatly facilitates harvesting and thinning of fruits as well as employing plant protection measure

(iii) This system is modification of the first two systems viz , central leader' and 'open centre' It is developed first by training the tree to the 'central leader' type and after some period, lateral branches are induced to grow, fairly well distributed, widely spaced, and spread on all sides but not very much open like 'open centre' Thus the tree is fairly strong and moderately spreading allowing easy to carry out orchard management operations.

16.3 Precautions

After the trees have been trained as per the desired form as explained above, they are to be maintained for their frame work by taking various precautions which are listed below

(a) Remove the branches arising from main or scaffold limbs after maintaining only one vigorous branch which is developed at a wider angle

(b) Remove the branches from their bases which are turning towards the central axis.

(c) Remove the water shoots i e., branches arising from the scaffold limbs, growing vigorously, and going straight at top. These are much thicker than normal branches, have much larger and coarser leaves These branches grow at the cost of fruit bearing ones This is very common in citrus trees If the frame work has been lost, some such vigorous branches are again retained to develop the frame work

(d) Remove the suckers which arise from the roots or underground parts of the stem or very close to the stem. This is observed commonly in guava and pomegranate In banana and in pineapple, where above training methods do not hold good, one or two suckers are retained according to the method of cultivation followed i e., ratooning system.

(e) Besides above, remove certain other lop sided growth to maintain the balance and frame work of the tree

16.4 Materials Required

(i) Diversified plants of assorted age groups
(ii) Secateur
(iii) Pruning knife
(iv) Small hatchet
(v) Hand pruning saw
(vi) Wooden stakes
(vii) Little rope for tyeing the main stem or branches

16.5 Procedure

16.a.5 *Simple staking*

— Select young plants of about one year old
— Prepare wooden stakes slightly more in height than the plant
— Fix the stakes close to the plant on lower side in the soil.
— Tie the main stem at a suitable distance of about 8-10 cm apart, at 3 or four places so that the stem does not bend for a pretty long period, till it becomes hard.

16.b 5 *Low headed type*

— Select a plant of about one or two years in age
— Remove all the lower branches on the plant upto a height of about 75 cm from the ground level and then allow further branches to grow,
— Observe the plants under heavy winds and bright sun shine

16.c.5 *High headed type*

Select a plant of about 1½ to 2½ years in age.
— Remove all the lower branches on the plant upto a height of about 125 cm or above from the ground level and then allow further branches to grow.
— Observe the plants under heavy wind and bright sun-shine.

16.d.5 *Central leader system*

— Select a plant one or two years old
— Allow main stem to grow straight and maintain the side small branches as such, so that the plant takes more or

less a rectangular form or shape of a cone without much spread

16.e.5 *Open centre system*

— Select a plant of about 2-3 years in age
— Behead the main branch and allow the side shoots to grow
— Maintain about 3-5 shoots, at a wider-angle, well spread in all the direction so as to develop good scaffold limbs os that the plant has a shape of inverted cone.

16.f.5 *Modified leader system*

— Select a plant 2-3 years in age.
— Remove the side shoots in such a manner that 3-5 shoots are retained on the main stem, well spaced and spirally arranged, spread at all directions so that the weigth of the plant is well distributed on these scaffold limbs and also the centre is not very much opened.

16.g 5 *Removal of water-and other shoots*

— Select big trees which have thrown water shoots growing strainght and also such other shoots on the branches which are growing towards axis.
— Remove the water sprouts and other shoots which are growing towards the central axis and over crowding

16.6 **Observations.**

The pupil should record the following observations at an interval of two to three months

(Tables a to h)

16.7 **Expected behavioural outcome**

The pupil acquires the following abilities to:

— identify the growth habit of plants;
— train the plants for 'low head' type,
— train the plants for 'high head' type;
— understand the effects of high velocity wind, high temperature etc on plants trained under 'low'and 'high head types,

— train the plants for 'central leader' 'open centre' and 'modified leader' system;
— remove water shoots and other undesired growth in plants;
— maintain wider angle between main or scaffold branches;
— maintain the main branches,well spaced and well spread at all sides;
— handle various tools required in training and after care of plants to maintain the frame work of the trees;
— carry out interculture operations in the orchards under various systems of training

The teacher should evaluate the pupils for the above abilities

16.8 Questions

(i) Give the advantages of training of fruit plants.
(ii) Enumerate the systems of training and give detailed procedure for open centre system.
(iii) Whether pruning improves effenciency of fruit crops for maintaining the frame work?
(iv) What after-care is necessary to maintain frame work of a tree?

(a) No training but staking:

Sl No.	Date of staking	Date of observation	Effect of staking on bend bended/errect	No of scaffold limbs retained	Remarks
1	2	3	4	5	6
i					
ii					
iii					
iv					

(b) Low headed/type

Sl No	Date of staking	Date of observation	Effect of staking on bend bended/errect	No. of scaffold limbs retained	Remarks
1	2	3	4	5	6
i					
ii					
iii					
iv					

(c) High headed type

Sl No	*Date of staking*	*Date of observation*	*Effect of staking on bend bended/erect*	*No of scaffold limbs retained*	*Remarks*
1	2	3	4	5	6
i					
ii					
iii					
iv					

(d) **Central leader system:**

Sl No	*Date*	*Height (cm)*	*Spreal (cm)*	
			East X West (a)	*North X South (b)*
1.	2	3	4(a)	4(b)
i. ii. iii iv				

(e) **Open centre system:**

Sl. No	*Date*	*Height (cm)*	*Spreal (cm)*	
			East X West (a)	*North X South (b)*
1	2	3	4(a)	4(b)
I II III IV				

(f) **Modified leader system:**

Sl. No.	*Date*	*Height (cm)*	*Spreal (cm)*	
			East X West (a)	*North X South (b)*
1.	2	3.	4(a)	4(b)
I II III IV				

(g) Removal of water-and other shoots:

Sl No	*Date*	*Water Shoots*		*Other Shoots*		*Remarks*
		No	*Weight (Kg)*	*No*	*Weight (Kg)*	
1.	2.	3		4.		5.
i ii iii. iv						

(h) Narrow crotches·

Sl No	*Date*	*Condition of narrow angle branches*	*Condition of side angle branches*	*Remarks*
		Broken/Healthy	*Broken/Healthy*	
1	2	3	4	5
i ii iii iv				

17. Activity Unit

Pruning of Fruit Plants

17.1 Instructional objectives

The pupil should be able to
— know about the fruiting habit of plant;
— maintain proper fruiting area in plant;
— remove the undersired growth of plant;
— do pruning in various fruit plants for giving them proper shape and for fruiting;
— handle the various tools required in pruning work.

17.2 Relevant Information

Removal of any part of the plant, in general is termed as 'pruning'

Method of pruning

Thinning: When a shoot or a branch is removed, entirely without leaving any stub.

Heading back: When terminal portion of the branch or shoot is removed partially, leaving the basal portion intact.

Extent of pruning If terminal portion of a branch or shoot is slightly removed, it is called 'light pruning'; when longer terminal portion is removed depending upon its severity it is called 'medium' or 'heavy' pruning

Why to Prune?

The pruning in fruit plants is done with different objectives in view. In some plants, it is limited to removal of non-productive parts for directing the nutrients to other parts that are capable of

bearing fruit 'Heading back' is a good practice in plants where fruit bearing shoots or spurs ate produced laterally from basal portaion of the past season's growth. It is aslo disadvantageous for plants which bear fruits on one years old terminal shoots as well as from other parts or the branch. In plants that bear fruits at the terminal portion of the shoots, no pruning or heading back should be done.

In some plants, particularly the vine crops, if pruning is not done, they become unwiedly and the production of fruits is greately reduced in course of time. Such plants, unless pruned, do not bear properly. By adopting appropriate pruning in such trees or vines, it is possible to maintain the tree or vine, productive for a longer time.

In some perennial evergreen fruit crops such as mango or sapota, very light annual pruning is desireable for some years mainly to train the tree to a desirable form. As the trees become old, they may become unproductive as in mango. In such cases, only the scaffold limbs or branches are retained and the other overcrowding branches arc heavily pruned. The vegetative growth is renewed and the tree bears satisfactory crop later.

Use of tools in pruning

There are many tools devised for pruning Most common ones are, pruning knives, shears, saws and secateurs. These tools are used depending upon the thickness of the branches involved in pruning. In addition, sometimes ladders are used for convenience of uses as an aid in saving time

Relation between pruning and training

In majority of evergreen fruit crops, very little pruning is involved for fruiting. The pruning is limited to only removal of dead-wood or for maintaining the framework of the tree The details are carried under the Activity Unit No *16* "Training of fruit Plants"

In crops which respond to pruning for fruiting, it is an important item of work. Pruning of shoots is done to induce new shoots, bearing flowers

The most important example of fruit crops is grape-vine. In this crop, pruning is essential to induce and regulate fruiting For details of pruning procedure for grape-vines, the teacher/pupil should refer the relevant activity in the manual on "Fruit Culture".

17.3 Precautions

— Avoid too light or too severe pruning which may result in over cropping or under cropping;
— Do not remove fruitful buds

17.4 Materials required

(i) Vine crop-preferably "grape vine"
(ii) Tree crop-preferalbly pomegtanate/guava.
(iii) Secateur
(iv) Hand pruning saw
(v) Hatchet (for removal of dried wood)

17.5 Procedure

— remove (preferably by hand) the leaves from the branches of trees or canes of the vine or bush.
— Prune the mature branches or canes by retaining the basal buds. The number of buds may vary from 3-10 or more, depending upon the type of tree The example for grapes, phalsa, guava, promegranate are as under.

Grapes	*Buds to be retained*
Var. Anab-e-Shahi	5
Var. Thomson seedles	10
Var Bangalore Blue	4
Var. Gulabi	4-9

Phalsa: Remove ⅓ or ½ of terminal growth of cane or shoot Promegrante and Guava: ⅓ terminal past season's growth. Remove all dead wood and other unhealthy growth on the vine or bush as a part of tree hygine

17.6 Observations

The pupil should record the following observations.

1 Tree/Vine
Name of fruit crop/variety
Date of planting.

Sl No of plant	Date	No. of shoots retained after pruning	No of shoots sprouted	% sprouting	No of vegetative shoots	No. of flowering shoots	% of flowering shoots	No of days required for flowering after pruning
1	2.	3	4.	5.	6	7	8	9
1 11 111								

17.7 Calculations

The pupil should calculate the following

(a) The percentage of fruiting canes on vine/bush
(b) The percentage of fruited or canes in each vine/bush.
(c) The total number of fruits or bunches

17.8 Expected behavioural outcome

The pupil acquires the following abilities to·

— understand the fruiting behaviour of fruit plants, trees/vines,
— apply appropriate method of pruning in crops for fruiting;
— judge the maturity of canes or branches for pruning;
— maintain the proper number of canes on each vine or bush,
— maintain the proper number of basal buds to be retained on each cane;
— maintain tree hygine;
— undertake actual pruning in vines or bushes in same important fruit crops of the region

The teacher should evaluate the pupil for the above abilities.

17.8 Questions

(i) What is the difference between thinning and heading back method or pruning?
(ii) In which fruit crops pruning for fruiting is essential and why?
(iii) How the severity of pruning is judged while selecting plant for pruning?
(iv) What will happen if the vine, fruit crops are left unpruned?

18. **Activity Unit**

Inducing Flowering in Furit Plants

18.1 Instructional objectives

The pupil should be able to.

—understand important factors associated with unfruitfulness in tree crops;

—know about the selection of various plant parts used in the operation of inducing flowering in plants,

—indentify the bad effects of the severe treatments like heavy root exposure, gridling,

—carry out the actual operation of bending, notching ringing, gridling, topping or pinching and root exposure.

18.2 Relevant information

Factors affecting fruitfulness

Furit growers face situations of poor or no furiting of trees in their orchards, though the trees are old enough to bear sizable crop. The studies indicate that there are various external or internal factors associated with this sort of situation in the orchard.

Amongst the external factors, environmental conditions prevailing just before, during or at the end of blossoming or fruit set, may play dominant role in making plants fruitful of unfruitful Also, the occurrence of pests, diseases, as well as nutritional status of the tree are all important

Similarly, the internal factors of the plant itself i.e., hereditary characrers, may be equally responsible for making a tree fruitful or unfruitful. Considering both the above mentioned factors, the orchardist shall have to manipulate his orchard management practices in such a manner that he will be able to over-come them for making the plants productive

(a) Bending

In this operation, the erect growing branches of trees are bent towards the ground without breaking them and are kept in this position till sprouting This is mostly adopted in tree crops which have erect growing habit

(b) *Notching*

In some fruit trees the branches growing erect do not sprout from the bottom part, but a few terminal buds sprout and produce fruits only near the top The basal buds remain dormant reducing the total potential fruiting area of the tree This is very true in fig plant. Therefore, this operation of notching, particulary just above the bud is carried out in order to induce more branches, thus increasing the fruiting area

Notching is also done below the bud in order to induce the individual bud to turn into a fruit bud But the practive of notching is quite cumbersome to follow on a large scale Hence it has not become a commercial practice.

(c) *'Ringing' or 'Girdling'*

This method is followed in some fruit crops for increasing the fruit buds In 'ringing' a narrow cut through the bark is given, whereas in 'girdling' wider piece of bark is removed If the area from where the bark is removed is very wide, there is possibility that the gap may not heal at all, and the tree may die Therefore, this practice of ring or girdling may have to be followed cautiously, and in extreme conditions only. In crops like grapevines, the caness or shoots are girdled to improve the quality of the fruits

(d) *Topping/Pinching*

In fact, this is a method of pruning But the severity is low It is limited to either removal of succulant terminal shoots or just pinching of the last terminal small portion of the shoot. It is practised in fruit plants or vines which are throwing shoots that are fast growing and thus the sap flow is diverted at the terminal end. To check this tendency and to divert the flow towards the growing flowers or small fruits, this method is followed.

(e) *Bahar treatment*

There is a tendency in some fruit crops including vine crops, to throw vegetative and flowery growth 3-4 times during the year This behaviour of plant in an orchard is not very desirbale. One good crop at a desired time is more desirable for good economic returns. Fruits developing and maturing at one time facilitate the orchard fertilization, irrigation to trees, watching, harvesting and all such other operations for a single cropping period Usually the fruit trees are treated for Ambe-bahar (spring flowering).

Therefore, this operation is carried out in fruit crops like guava, citrus and pomegranate in certain areas where they almost flower continuously to obtain a single good crop

Simple Bahar treatment consists of with-holding of water to an orchard for a period ranging from about 3-6 weeks prior to the desired commencement of flowering depending upon the type of soil where the orchard is located In heavy and water retentive soils, the period of witholding of water is more as compared to lighter types of soils Sometimes, it is not possible to withhold the water for such a long time, particularly before the rainy season.

In certain other situations, in addition to simply withholding of water, additional treatment of root exposure is also employed The surface soil under the tree canopy is opened up by digging and removing the soil little away and thus exposing the roots in the upper 15 to 22.5 cm layer of the soil In this operation, some fibrous roots are cut or damaged. In extreme conditions, actually the roots in the exposed part of the soil are pruned and the basin is exposed for a week or ten days to facilitate good flowering

Note. Internal factors involved in unfruitfulness have to be tackled in a different manner and are not therefore discussed in the present unit

18.3 Precautions

- For bending, select branches of plants which are not too woody.
- Tie the branches firmly
- For notching in fig plants, check the oozing out of latex-through the bark while notching To avoid this, a slanting cut above the bud be made.
- In ringing or girdling, do not remove wide bark otherwise it may not heal.

— Avoid deep cuts while rining/notching
— In topping or pinching, carry out the operation when new shoots are of 45 to 75 cm length with or without inflorescence or flowers
– In Bahar treatment, withhold water to the plants till they show temporary wilting symptoms If the period of stress is too much, there is a danger for the plant to die.
— Do not expose roots for more than 8-10 days
— Treat the pruned roots immediately with fungicide solution
— Give necessary support to plants where roots are exposed or pruned as the tree is vulnerable to strong winds

18.4 Materials Required

(i) Unifrom trees or vines of bearning age.
(ii) Pruning knife
(iii) Chisel for large trees
(iv) Hand pruning saw for ringing or girdling opertion
(v) Rope for tieing of branches to keep them in position
(vi) Secateur or pruning shear for topping or pinching shoots or pruning of roots
(vii) Spade
(viii) Kudali or digging fork for digging soil and for root exposure

18.5 Procedure

18 a.5 *Bending.* (Use ereet growing guava trees)

— Sclect branches on a tree, on all sides which are growing erect.
— Bend these branches and their ends in an arched fashion with similarly bent branchess of the neighbouring tree

18.b 5 *Notching:* (Use fig tree which responds well to notching)

— Remove a small narrow strip of bark just above and close to a dormant bud on a selected branch of the tree for inducing vegetative growth which will bear fruits.

18.c.5 **Ringing or Girdling:** (Mango and grape respond well to ringing on trunk or limbs)

— Remove narrow but complete ring of bark from a branch or trunk with the help of a pruning knife

18.d 5 *Topping or Pinching* (Grapes or succulant branches of plants respond well)

— Pinch or cut young succulant shoots by hand (10-15 nodes beyond the cluster in grapevine) by using a secateur.

18 e 5 *Bahar Treatment.* (Citrus trees, guava, pomegranate, phalsa etc. respond well)

— In simple treatment, withhold water, 4-6 weeks prior to expected flowering till the plants show temporary wilting symptoms

— In severe treatment, dig soil to a depth of 15-20 cm around the tree trunk (about 90-100 cm radius) and expose the roots.

— In still further severe treatment, prune about 25-30 per cent of fibrous roots.

— Manure the trees in all the above situations

— Water/irrigate after 4-6 weeks when plants show wilting and shed the leaves

18.6 **Observations**

The pupil should record the following observations

(i) Name of tree or vine
(ii) Variety.
(iii) Type of soil (shallow, medium, deep)

Sl No	Treatment	Days required from observation to	No. of Buds sprouted	No of Buds fruited	% of fruitful Buds	Remarks
1	2	3	4	5	6.	7
(a)	*Bending* (i) Date of operation					
	(ii) No of branches bent					
(b)	*Notching* (i) Date of operation					
	(ii) No of buds notched					
(c)	*Ringing/girdling* (i) Date of operation					
	(ii) No of branches ringed or girdled					
(d)	*Tipping/pinching* (i) Date of operation					
	(ii) No. of shoots topped/pinched					
(e)	*Bahar treatment* (i) Date of withholding water					
	(ii) Total No. of days of withholding water					

	(iii) Total No of days or root exposure without pruning (if any)					
	(iv) Total no of days of root exposure with root pruning (if any)					

18.7 Calculations

The pupil should calculate the following:

(a) Percentage of fruitful buds to total buds
(b) Percentage of fruitful buds to buds sprouted
(c) Weight of roots pruned in root pruning
(d) Weight of pinched or topped plant parts

18.8 Expected Behavioural Outcomes

— The pupil acquires the following abilities to:
— select proper plant material for the operation;
— observe the correct symptoms of tempeorary wilting;
— understand the bad effects of severe treatments like heavy ringing, girdling, excess root exposure, root pruning and deep notching;
— pick up the good effects of correct treatment applied to the plants selected;
— pinch or top the branches at correct stage of plant growth,
— do himself the special practices of bending, notching, ringing, girdling, topping, pinching, simple withholding of water to plants, root exposure, rootpruning

The teacher should evaluate the pupil for the above abilities

18.9 Questions

(i) Enlist the various practices followed for inducing fruiting in plants Give two examples of fruit plants in each

(ii) Give procedure to be followed and precautions to be taken in carrying out the following operations
  (a) (i) Ringing/girdling
    (ii) Bending.
  (b) (i) Notching
    (ii) Topping/Pinching.
  (c) (i) Bahar treatment with root exposure
    (ii) Bahar treatment with root exposure and root pruning.

(iii) *What will happen if*
  (a) notching is done above the bud in fig?
  (b) complete but wide ring of bark is removed from the shoots?

(c) heavy root pruning is done?
(d) roots are exposed for a very long period?
(e) the water to a plant is withheld beyond the stage of temporary wilting?
(f) The shoots are pinched or topped after they have made excessive growth.

(iv) How much time is required for sprouting of buds and flowering after carrying out the following operations in specific fruit plants?
(i) Bending (in guava)
(ii) Notching (in fig).
(iii) Ringing/girdling (in grapes).
(iv) Topping/pinching (in grapes)
(v) Root exposure (in guava or pomegranate)
(vi) Root pruning (in citrus fruit).
(vii) Simply withholding water (in citrus fruit) for bahar treatment

19. **Activity Unit**

Improving Size and Quality of Fruits

19.1 Instructional Objectives

The pupil should be able to:

— select proper plant material;
— identify proper stage of giving the treatment to the plant or parts thereof;
— prepare proper solutions of gowth regulators;
— select proper gowth regulators for treatment;
— do himself the operations viz , thinning of blossoms, thinning of fruits under heavy cropping; girdling and or pinching of shoots;
— apply the growth regulators to proper plant parts,
— observe the difference between good quality and inferior fruit by feel, appearance and taste.

19.2 Relevant Information

It is commonly seen that there is sometimes deterioration in the qaulity of fruits by one way or other. This may be due to heavy cropping, less vigour of branches, adoption of wrong or untimely cultural practices, occurrence pests, diseases or inherent defects in plant itself

To some extent the size and the quality of the fruits can be improved by adopting certain practices which can be carried out in a simple manner and also to some extent with lesser cost. Some of them are as under:

(a) *Thinning of blossoms*

This is done in such fruit trees which flower and set fruits heavily

(b) *Thinning of fruits*

When there is heavy fruit set, there is always competition amongst the developing fruits for their nutrition. The result is that the fruits are of poor quality. Under such conditions, a few young fruits are removed either mechanically or by employing certain chemicals, so that the remaining fruits improve in size and quality. This is commonly done in peach, plum and apricot

(c) *Girdling*

Girdling of canes is practised in many grape varieties 0 5 to 0.75 cm wide strip around cane is removed This is practised on individual cane at second or third internode from the base immediately after fruit set For further information the pupil may refer to item 18 2.

(d) *Pinching*

Grapes have shown good response to pinching It is a practice in Anab-e-Shahi and Thompson Seedless varieties of grape to remove the new growth leaving 8-10 leaves beyond the bunch, besides removal of other unproductive shoots

(e) *Use of growth regulators*

Use of some growth regulators had become common in grape cultivation in the country for improving the fruit quality. In some other fruit crops, it has yet to gain pupularity Compactness of the bunch can now be reduced, particularly in Thompson Seedless grape by treating the panicles with 15 ppm G.A. solution (15 mg/ litre of water) at full bloon stage Again to improve the individual berry size, the bunches are dipped in 60 ppm G A solution for 10 seconds at fruit set Similarly, the shoot-berry formation is reduced by applying 50 ppm G.A. solution to the panicels of Gulabi variety at 5-6 days after full bloom

19.3 Precautins

- Make sure that there is heavy set or fruits even after natural fruit drop.
- Undertake flower thinning or cluster thinning only in such fruit varieties where there is less flower drop.
- Carry out girdling in canes or shoots of such varieties of fruit crops where thinning of flowers is over

— Make sure that the growth regulator solution is fresh and is of correct concentration
— Undertake dipping or spraying operation during cool hours of the day.
— Pinch off the shoots immediately after flowering for better fruit set and development.

19.4 Materials Required

(i) Fruit trees or vines of bearing age.
(ii) Secateur, girdling knife
(iii) Pruning knife.
(iv) Plant growth regulator solution of required concentration
(v) Spraying equipment (Knap-sack sprayer).
(vi) Plastic containers for dipping bunches

19.5 Procedure

(a) *Blossom thinning (Grapes)*

— Spray the solution on inflorescences or
— Dip the blossom in the spray solution (for Thomson seedless variety of grapes–15 ppm G.A solution is used at full bloom stage). (15 mg/lit. of water)

(b) *Fruit thinning* (Papaya/Plum)

— Remove samll or crowded fruits by hand

(c) *Girdling*

— Remove the bark (2-3 mm wide) of the branch or cane just below the bud from where the cane has arisen, or
— Girdle the main limb or shoot.

(d) *Pinching*

— Remove the succulent terminal portion of the shoot either by hand or with the help of secateur (in case of grapes, 8 to 10 leaves beyond the bunch are retained and the rest of the portion is topped off).

19.6 Observations

The pupil should record the following observations.
(i) Name of the crop
(ii) Variety

Sl No	*Particulars*	*Untreated*	*Thinned*	*Girdled*	*Application of growth regulator*	*Remarks*
1	2	3	4	5	6	7

(iii) Date of operation

(a) *Bunch characters*·

(i) Appearance
Bright
Dull

(ii) Compactness (by feel).
Very compact
Well filled
Loose
Vary loose

(iii) Weight (g).

(b) *Berry/fruit characters*

(i) Size (by weight).
Big
Medium
Small

(ii) Shape
Long
Round

(iii) Taste
Sweetish
Acidic
Insipid

19.8 Expected Behavioural Outcome

— The pupil acquires the following abilities to·
— do thinning of blossoms and fruits;
— select preper growth regulators and prepare the solutions of growth regulators;
— identify the stage of flowers, blossoms or fruits suitable for thinning,
— identify the stage of flowers blossoms or fruits suitable for thinning,
— do the girdling and pinching of shoots:
— know the time to spraying of growth regulator solution on plant or parts,
— observe the differences between good quality fruit and inferior fruit by feel, appearance taste.

The teacher should evaluate the pupil for the above abilities

19.9 Questions

1 Describe the characters of a quality fruit as compared to ordinary fruit (inferior) in respect of appearances, feel, weight, taste etc.
2 What steps you will suggest in improving the quality of fruits in tree and vine crops? Give examples.
3. How are growth regulators useful to orchardist for improving his crop qualitatively?
4. Suggest the precautions to be taken while spraying growth regulator solution

20. Activity Unit

Study of Alternate Bearing in Fruit Tress

20.1 Instructional Objectives

The pupil should be able to.

- understand alternate bearing in certain fruit trees,
- observe different vegetative flushes and flowering in relation to alternate bearing;
- predict behaviour of bearing in mango;
- know possible remedies to overcome alternate bearing

20.2 Relevant Information

What is Alternate Bearing?

Tendency to bear economical crop in alternate years is known as alternate or biennial bearing. The year in which the cropping is heavy is known as 'On' year, and the following years when the crop is lean or there is no crop is known as 'Off' year This tendency to bear heavy crop in one year followed by a poor or no crop next year is commonly observed in mango, generally after the plants attain an age of 10-12 years. This tendency is very much associated with vegetative flush and its maturity

Alternate Bearing In Mango

In mango, flowering season is from January to March depending upon the region. These flowers are produced on the vegetative growth of January to July flush of the previous season. Flower bud initiation takes place 30-40 days after flowering. If there is no new spur at the time of flowering there will be no good crop in the following year.

Why Alternate Bearing?

Alternate bearing in mango and apple is considered to be a varietal trait The important factors that aggrevate alternate bearing are poor management practices particularly in respect of utilisation and plant protection

How to Overcome Alternate Bearing?

This tendency of alternate bearing can be overcome to some extent either by adopting recommended cultural practices and plant protection measures and use of growth regulators like Ethrel–an ethylene releasing chemical. In apples, flower thinning in the 'On' year has resulted in overcoming this tendency partially. Hand thinning is time consuming and cumbersome Chemical thinning by growth regulators such as NAA has given good results

In mango while some commercial varieties of North, like Safeda, Dashahari are biennial bearing, varieties like Neelam and Totapuri from South are known for their regular bearing habit.

20.3 Precautions

— Select trees of one cultivar for observation.
— Select trees of uniform age

20.4 Materials Required

(i) Weighing scale.
(ii) Yield/Crop produce register giving tree-wise yearly yield data.

20.5 Procedure

— Select 8 trees randomly from a uniform orchard of any one variety of mango of more than 10 years of age
— See that four trees should be having heavy crop and four with light crop.
— Mark these trees properly as tree number 1-8.
— Harvest fruits of these trees separately. Count, weigh the fruits and record separately for each tree.

20.6 Observations

The pupil should record the following observations in the given tables

Table 1

Tree No.	Vegetative Growth (Duration)						Flowering Duration		*Intensity
	Flush-1		Flush-2		Flush-3				
	From (a)	To	From (b)	To	From (c)	To	From	To	
1.	2						3		4

*Classifiy intensity as 'No flowering', 'Light'; 'Medium'; 'Heavy'

Yield of Mango Fruits in 'on' and 'off' Years

Table 2

"ON" year								Tree No	"OFF" year					
Date of Harvest						Total			Dates of Harvest					
No (a)	Wt. (b)	No (c)	Wt. (d)	No (e)	Wt (f)	No (a)	Wt (b)		No (a)	Wt (b)	No (c)	Wt (d)	No (e)	Wt. (f)
2.						3		1	2					
								1						
								2						
								3						
								4						
								5						
								6						
								7						
								8						

Compare this yield from the yield of these trees as given in tree-wise yield register

20.7 Expected Behavioural Outcome

The pupil acquires the following abilities to
— understand causes of alternate bearing;
— observe different vegetative flushes,
— observe intensity of flowering,
— associate vegetative growth flushes with flowering.
The teacher should evaluate the pupil for the above abilities.

20.8 Questions

(i) What is alternate bearing?
(ii) What are the causes of alternate bearing?
(iii) What is a mixed panicle?
(iv) What are the seasons of vegetative flushes of mango in your region/state?
(v) Suggest some methods to overcome alternate bearing
(vi) Name some mango cultivars which are regular bears.
(vii) Name two commercial cultivars which are irregular bearers

21. Activity Unit

Determination of Maturity Standards for Harvest in Fruits and Fruits Ripening

21.1 Instructional objectives:

The pupil should be able to.

- identify characters of the fruits which help in the determination of the maturity of fruits for harvest,
- understand the physical changes that take place during ripening;
- know different types of fruit ripening;
- known factors accelerating fruit ripening.

21.2 Relevant information

What is fruit maturity?

When a fruit acquires characteristic size and shape and is ready for harvest it is said to be mature The stage of maturity of fruit at harvest decides the quality of fruits. The harvesting of immature and overmature fruits lowers the quality of fruits

Maturity indices of fruits

The right stages of maturity of fruit for harvest can be determined by observing size and shape of the fruit. Other indices are colour change, decrease in firmness and increase in total soluble solids

What is fruit repening?

— A mature fruit undergoes physical and chemical changes before it becomes edible. During ripening it often looses its green colour, there is decrease in acidity, softening of the tissues, increase in sugar content and the development of characteristic small

Type of fruit ripening

There are two types fo fruit ripening.

(i) Climacteric
(ii) Non-climacteric.

Climacteric fruits are those in which ripening of fruits takes place after harvest. Non-climacteric fruits on the other hand are those in which the ripening of fruit is complete while on the plant and they fail to ripen after they are harvested from the plant eg grape.

Artificial fruit ripening

It is possible to induce artifical repening in fruits by the application of certain chemicals like Ethrel. Ethrel produces ethylene—a fruit ripening hormone, which sets in physical and chemical changes of fruit ripening

21.3 Precautions

— Harvest fruits of right maturity
— Select fruits of right maturity.
— Do not mix fruits with matured ones, as it will accelerate fruit ripening.

21.4 Materials required

(i) Banana/fruits.
  (a) Immature (fruits highly angular)
  (b) Partially matured (fruits started losing angularity)
  (c) Fully matured (fruits more or less cylindrical in shape)
(ii) Ethrel
(iii) Grape branches
  (a) mautured but unripe
  (b) Berries in bunch ripened on the vine itself
(iv) Paddy straw.

21.5 Procedure

(a)
— Select banana fruits of different maturity
(i) Immature

(ii) Partially mature
(iii) Fully matured
— Allow them to ripen and assess their quality
(b)
— Select three sets (24 fruits in each set) of fully matured banana fruits
— Cover one set with paddy straw.
— Threat the second set of fruits with ethrel by dipping in ethrel solution of 250 ppm concentration for two minutes.
— Leave the third set as such under room temperature conditions.
— Follow the rate of ripening of fruits in each set and record observations.
(c)
— Procure two bunches of grapes
(i) Berries fully matured but unripe.
(ii) Berries fully ripened on the vine itself
— Assess the berries as per observations

21.6 **Observations**

The pupils should record the following observations.
The maturity of the fruits in banana/mango

Mango *Banana*

(i) Fruit size
(ii) Fruit shape
(iii) Colour
(iv) Firmness
(v) T.S.S

Number of days required for ripening of banana
(i)Covered with paddy straw
(ii) Treated with ethrel
(iii) Untreated

Physical changes taking place during the ripening of banana.

Character	Matured fruit	Ripened fruit
(i) Colour		
(ii) Firmness		
(iii) Taste		
(iv) Flavour		

Ripening changes in grape barries:

Characters	Berries not ripened on vines	Bararies ripened on the vine
(i) Colour		
(ii) Firmness		
(iii) Taste		
(iv) Flavour		

21.7 Expected behavioural outcome

The pupil acquires the abilities to·

— judge the maturity of fruits for harvest;
— understand the physical changes that take place during fruit ripening;
— know the differences in the ripening of climacteric fruit like banana and non-climacteric fruit like grapes,
— ripen certain fruits artificially by ethrel application.

The teacher should evaluate the pupil for the above abilities.

21.8 Questions

(i) Indicate physical changes that take place during fruit ripening.
(ii) The grape berries do not ripen once they are removed ffom the vines Why?
(iii) Covering of fruits with paddy straw will hasten ripening. Why?
(iv) What happens when immature fruits are harvested and allowed to ripen?

Appendix-I

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